Technology at the Transition

Relationships between culture, style and function in the Late Iron Age determined through the analysis of artefacts

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Summary of thesis

The principle aim of the thesis was to examine the technology of Late Iron Age decorated metal work at a time of dynamic change from both internal and external factors. The objects chosen for this study were predominantly from dry land hoards, and superficially had many aspects in common. The majority of these hoards were deposited in Britain in the mid first century AD (slightly later in the case of Middlebie in south west Scotland), and located in areas of attested historical conflict with the invading Roman army.

Predominant amongst the kind of objects in the hoards were those associated with horses and carts or chariots; an artefact type of social and historical significance to native British Iron Age societies. It is argued that the manufacture, use and deposition of these objects were important factors in maintaining relationships between different Iron Age groups in the face of threats from an invading force.

Chemical analysis of objects from this period is important. The first century AD witnessed both technological sophistication and conservatism as the Iron Age metalworkers confronted the introduction, through continental influence and the Roman army, of new materials such as brass, and the re-introduction of piece moulds and leaded copper alloys. Coloured Roman glass was also introduced and used in many parts of Britain, but Insular La Tène style metalwork continued to be decorated using *sealing wax red glass* (a specific Iron Age technology). On the whole, an innate conservatism in object styles and materials was maintained, irrespective of acquired knowledge and the availability of new technologies. In fact, Late Insular La Tène art developed and flourished, as some indigenous Britons adopted a strong identity through the use of specific objects, technologies and artistic styles; recognisable throughout large parts of Britain.

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Chapter 1. Introduction

Aims

This thesis looks at technological changes in a group of metal artefacts found in Late Iron Age hoards in Britain. The hoards date from the first century AD, the time of the Roman conquest of Britain and a period of cultural, social and political upheaval. It is hoped that the detailed study and analysis of these specific artefacts sets will illuminate factors such as the adoption, adaption and rejection of techniques. The investigation of metalworking, decoration, and art styles evaluated in conjunction with archaeological theories and historical narratives could help contribute to an overall understanding of the period. Although this is a relatively small component of information within the academic study of the period when viewed in isolation, it is one that gives tangible evidence within discrete localised contexts in geographical, chronological and cultural terms.

Rome versus Britain

The overall picture of Britain at this time is complex; Roman rule took hold in many different forms and guises. For example, there were the needs of the Roman Empire and the military in relation to the indigenous response to alliances and conquest, which varied greatly between regions. Further complexities ensued with the increasingly multifaceted mixture of people that arrived with the Roman army, which included 'Roman' auxiliaries from many different areas of the Empire who interacted with local communities in military settings, the 'vicus', and in towns settled by veteran troops. So despite the unifying aspects of imperial Roman rule discrete areas of Britain under Roman control were treated and reacted very differently (Mattingly 2006).

Much is unknown about many aspects of the invasion. Roman historians give a biased but interesting insight into particular areas, battles and personalities; mostly Romans are mentioned, plus some of the more notorious Britons – usually rebels or women. The archaeological evidence suggests that Iron Age Britain was diverse in its political and social structures. Although the south and south east of England is the most heavily studied area, it is not necessarily representative of other parts of Britain, particularly regions that rebelled, such as Norfolk, or which underwent protracted conflict with the Roman army, such as Wales, northern England and Scotland. These areas either refused to be 'Romanised' or were not permitted to adopt Roman civilian practices due to their entrenched hostility (Mattingly 2006, 369). It is in these regions that many of the artefacts studied here were deposited, and where particular styles of art and technology were maintained or adapted.

Academic division and integration

Historically, the material culture of the first century AD in Britain has often been placed into artificial academic sub-divisions and fallen between disciplines, rather than examined as a dynamic narrative in its own right. These separations are apparent between prehistory and ancient history, between Iron Age archaeology and Roman archaeology, and by the division of material culture in art historical narratives into 'Celtic art' and classical art. In recent years it has been recognised that transitional periods provide dynamic evidence for cultural change that are of great interest to archaeologists.

The dating of first century AD material is imprecise; 'prehistoric' from this period is a relatively arbitrary term in relation to material culture, decided by artefact style, context and associations, that depend on historical interpretations of similar material. If objects were produced by the nonliterate indigenous population they are prehistoric; otherwise they are Roman or Romano-British. However, it is difficult to deem an object as 'native' or Roman/Romano-British when dated from such a dynamic period of changing allegiances and political upheaval; a lack of integration of objects in many museum displays reiterates differences in public perception. Although some of these differences derive from modern investigation, taste and bias, it is important to recognise that equally valid attitudes could have been present in the past. This makes the study of some of the material culture difficult to disentangle and impossible to summarise or compartmentalise. Jones sums up part of the issue: 'at both the practical and theoretical level we are required to simultaneously consider how it is that artefacts are socially and culturally constructed, while also taking into account the physical and mechanical construction of artefacts' (Jones 2004, 329).

Analysis of artefacts is often done on a relatively *ad hoc* basis for site reports, and not always fully integrated into an overarching archaeological interpretation. For example the Seven Sisters Hoard has been examined systematically by Davies and Spratling (1976); and analysis of some of the objects has been undertaken by Northover (1999 133-143) and Henderson (1989); but the scientific data is partial, isolated from its immediate context and largely unpublished.

Within this study interpretation of analyses will use the evidence from history and archaeology, in conjunction with scientific data from a particular set of objects, to help build a larger picture of the cultural 'melting pot' of the time. As Jones (2002) points out, macro and micro analysis involving the interplay of material culture, science and the humanities is important, and it is necessary that the study of material culture is not peripheral or slightly removed from the main historical and archaeological arguments. Jones perceives this is a particular problem for scientific analysis where the physical separation, by the sampling of data and its processing, results in interpretations and generalities not always relevant to the understanding of specific past societies (Jones 2002).

The artefacts

The objects studied here are mostly from metalwork hoards deposited in the mid to late first century AD (or possibly the early second century AD in the case of Middlebie); predominantly at the time of the Claudian invasion (43AD) and subsequent conquest (chapter 2; 3). The major hoards of the type studied here can be grouped by a number of factors: they appear to contain specific types of objects, especially horse gear, but also often objects related to feasting and drinking, military dress, personal ornament such as brooches and sometimes metalworking waste (Gosden and Garrow 2012). They seem to be associated with individuals of relatively high social status and many, but not all demonstrate high quality craftsmanship. The forms, designs and decoration of the objects used in these hoards imply a strand of society that adhered to a unifying cultural tradition. There are also parallels in the geographical locations in which the hoards were deposited, usually areas in direct military conflict with the Roman army. This is despite the fact that the hoards are found across different regions of Britain, which archaeological evidence suggests had very different social practices (see Chapter 2) e.g. Hill 2007; Sharples 2010; Moore 2006; Hazelgrove and Moore 2007).

The dramatic increase in the production of decorative copper alloy metal work at the end of the Iron Age and during the Roman conquest (Garrow 2008) raises questions as to why so much was produced at this period, and decorated so specifically. Further unifying elements related to the hoards are their burial on dry land (compared to many watery deposits such as Llyn Cerrig Bach (Macdonald 2007), Carlingwark (Manning 1972), and Fiskerton (Field and Parker Pearson 2003)), and that often a number of the objects were burnt and/or broken. The inclusion of Roman material and stylistically datable material such as brooches helps secure these artefacts into a particular time frame as well as creating a further aspect to their complexity.

In the Iron Age, bronze seems to have been a relatively scarce commodity in everyday life, although there was an increase in availability in the first century AD. On occupied sites such as hillforts and enclosures surviving bronze tends to be either sheet fragments, believed to be associated with cauldrons and vessels (Cunliffe & Poole 1991; Sharples 1991; Wainwright 1979; etc), small brooches and other trinkets, with only very occasional prestigious artefacts. Most finely worked daggers, shields, and helmets in Britain come from rivers such as the Witham and the Thames, though prestigious swords and horse harness equipment are found in the exceptional burial traditions of Yorkshire.

The acquisition of copper and tin, the constituents of bronze, would have required specific trade and exchange relationships. However attained, the material then required skilled craftsmanship and appears to have been worked by accomplished and expert metalworkers. Artefacts were often made of decorated beaten sheet bronze using highly modelled repousse work, or cast using investment moulds; the cast shape also often formed an important element of the design, with the three-dimensional aspect of the object often playing as important a role as additional decorative elements or motifs (for example lipped terrets or massive armlets). Investment moulds meant that each object was unique and individually made; even where pairs of 'identical' objects were produced, such as at Polden Hill, the dimensions and weights are always slightly different. These high status artefacts were also modified in response to new materials and technologies entering Britain.

'Technological Choice': style and function

The process of selection of technological practices whether developed locally, borrowed or adapted for use is known as technological choice (Lemonnier 2002, 2). When assessing technologies used in all societies, many considerations need to be taken into account other than the purely logical ones such as efficacy and cost; 'social logics unrelated to technology weigh heavily on the evolution of technological systems' (Lemonnier 2002, 2). In this respect, the technological choices and the social systems operating within society become inextricably combined, and in archaeological terms it is often difficult to resolve the complexities induced by social and symbolic considerations which cannot be determined from material evidence alone. 'It is as though societies chose from a whole range of possible technological avenues that their environment, their own traditions and contacts with foreigners lay open to their means of action on the material world' (Lemonnier 2002, 6). The importance of all these aspects of choice must be recognised when assessing the artefacts in this study. 'Simplistic utilitarian/non-utilitarian functional classifications lead to equally simplistic inferences of prehistoric activities from archaeological contexts. Obvious interpretations based on the assumed functions of artefacts can be deceptive when detailed contextual clues are not considered' (Walker and Lucero 2000, 133). Evidence of what was made and how, plus patterns in ancient use can be logged and analysed. Equally, anthropological evidence of the practices of other societies contribute an important element to the understanding of an unfamiliar mind set, and are an important source for comprehending theories on some of the ways social constructs impact on technological choices. 'The object is the sum of its form and materials but a great deal more, for it is deeply embedded in a living, changing web of beliefs and values' (Herbert 1984, 239).

The period covering the first century BC to the first century AD, is particularly important in the understanding of technological change in Britain. In the Late Iron Age Britain was heavily influenced by both the near continent Celtic and Roman worlds via contacts and trade. Subsequent technological choices brought about by the Roman invasion reveal much about the indigenous societies' attitudes to and use of material culture, well beyond the practical use of artefacts. The causes of technological change are also important, as social and regional identities often play a crucial role in the adaptation of technologies: 'Factors dealing with *status or group identity*, which can be assigned to a single social function, that of defining an individual's or group's identity, are no surprise. As Lévi-Strauss (1985) wrote, basic to the diversity of cultures is "the desire of each culture to resist the cultures surrounding it, to distinguish itself from them – in short, to be itself"' (Lemonnier 2002, 18).

Another complex layer to such investigations is the art and design of specific objects. The 'use' of 'styles' whether symbolic or to denote status etc. is another choice which has a bearing on the materials used. It is sometimes not considered in direct relation to 'technological style', as the material aspects of techniques have a physical effect, whereas 'investigating variations of shapes and decoration, which are of little material consequence are aimed primarily at conveying a "message"' (Lemonnier 2002, 10). However, art/decoration is also part of the social element of the choice of materials and technologies, and can be a response to material and technology. Within an art-historical argument Hunter questions 'Are we dealing with regional styles, or preferences among particular social, political or ethnic groups? ...Does this reflect deliberate resistance to Rome; or an accommodation; or variable reading in different contexts? The starting assumption here is that these were more than simple decorative survivals; they were active social objects with significance to their use' (Hunter 2008, 131)

Assessing changes in technological style, and looking at the '*chaînes opératoires*' of artefacts made and used in this period can clarify divergences in the manufacturing and use of similar artefacts from different cultural bases and using different materials. 'Sometimes it is not an artefact that marks a particular social status or identity, but entire sets of technical *processes*' (Lemonnier 2002, 19). Hamilton (1996) discusses in some detail how such theories and methods of examining technology have developed and could be applied to the assessment of metalwork from the continental oppidum of Titelberg, during a similar period of upheaval; Ottoway and Roberts (2008) use '*chaînes opératoires*' to dissect the technologies used at the time of the emergence of metalworking in Europe in order to gain insight into early metal use and production. The life history of an object as an active player in the relationships between people making, possessing and disposing of it, and enables an assessment of its importance and contribution to the identities of those involved with the object. It also highlights the resources necessary in terms of material, contacts, and geography for its history to come about. Many details need to be hypothesised, but where consistent patterns emerge cultural difference can be explored.

Direction of study

The increased data on decorated Iron Age copper alloy artefacts, especially those dating from the time of the Roman conquest, provides an opportunity to look at objects and their association with different regions and identities. Stylistically this has been attempted by many archaeologists, i.e. Leeds (1933), Jope (2000), Fox (1958), but no one has done this through an examination of material science and technology. By assessing the technical and material evidence of Late Iron Age and Early

Romano-British copper alloy artefacts, it should be possible to put analytical results into a theoretical framework. This would clarify the impact of an occupying force with a contrasting culture, and highlight patterns of assimilation and rejection of material and social practices in regions of resistance and confrontation. This is especially so with decorated objects which are using developing technologies - that of bronze and brass, and glass and enamel. An assessment of these artefacts will include consideration of factors such as object type, use, decoration, colour, manufacture and depositional practice.

By establishing the different technologies used for producing these materials, for example bronze versus brass; lost-wax moulds compared to piece moulds, inlaid glass versus enamelling; the use of lead within castings, and decorative techniques such as silvering, tinning and the use of niello etc. their interplay can be analysed in much more detail (Davis and Gwilt 2008)

Examining technologies in conjunction with the type of object made, the style of the object and the deposition practice and its location gives insight into how these artefacts were used, altered and rejected by native Iron Age Britons. In many ways such ostentatious metalwork with its very particular designs would send out strong messages to peers and other echelons within society as to where tribal elites stood in relation to their peers and possible conquerors. These objects, many displayed on horses and chariots, or at communal feasting were a fundamental way of expressing position and status and could be seen as emblems of allegiance to others also possessing similar material (Jundi and Hill 1998).

The change in the quantity of material culture available to view rises significantly in the Late Iron Age/conquest period (Garrow 2008, 31), and again in the Romano-British period proper (Dungworth 1997, 4.3). Roman material, designs and manufacturing processes became increasingly incorporated into native artefacts and designs, eventually developing their own trajectory as Imperial control became established (Hunter 2008).

Focus of chapters

The thesis will give a general introduction to the archaeology of the pre-Roman Iron Age, and the history of the conquest as interpreted through the Roman source material. This is followed by chapters on copper alloys and glass that consider the significance of these materials and previous analytical work, and provide a context for the elemental analysis used in the subsequent case studies.

The main bulk of the study is the detailed analysis of four Late Iron Age hoards: from Polden Hill in Somerset, Seven Sisters in South Glamorgan, Santon in Suffolk and Middlebie in Dumfries and Galloway. They are all housed in Museums and have been researched or catalogued before to some extent, but this thesis is the first attempt to examine their elemental composition as well as their form systematically. Within these chapters there are several further issues discussed which are relevant to much of the material, but are dealt with in more detail in particular chapters. For example the life histories of objects are discussed in relation to the Polden Hill hoard; the application of glass and the development of enamel *strictu sensu* is discussed in relation to the variable inlays used in the Seven Sisters hoard, as well as the significance of colour. The importance of vessels and communal drinking is considered in the chapter on the Santon hoard, and the relationship between the number of horse pieces such as terrets and bridle-bits, and potential 'sets' of harness equipment are examined in relation to Middlebie. These hoards have many aspects in common, but one of the most important of these is the inclusion of horse harness equipment. As this is such an important and repeatedly cited group of objects a chapter is included on the significance of horses in the Iron Age.

The examination of each of the hoards leads to some conclusions relevant to each group of material, but further discussion is presented in the final conclusion.

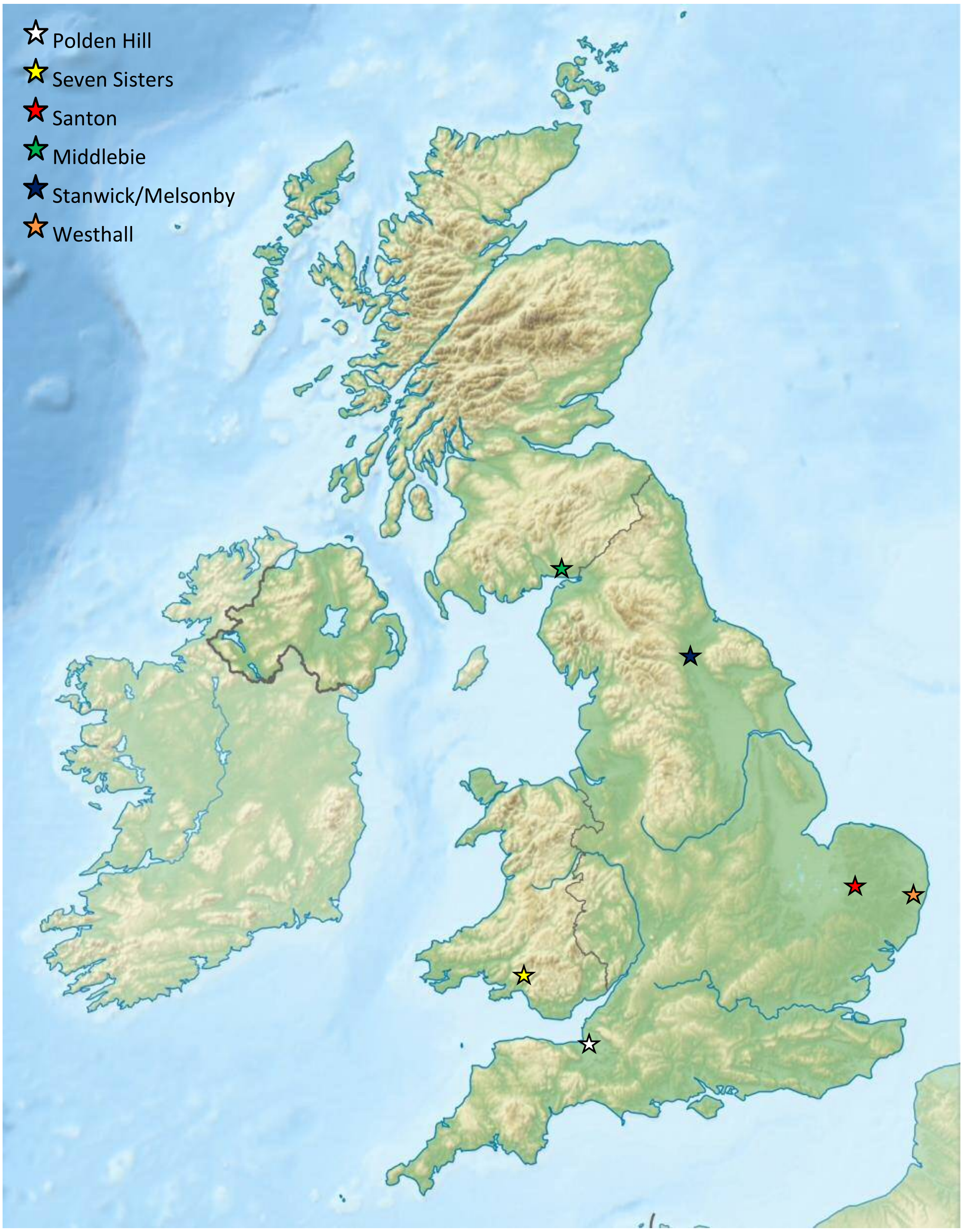


Figure 1. 1: Map showing location of Late Iron Age hoards referred to in the thesis.
http://upload.wikimedia.org/wikipedia/commons/d/d7/United_Kingdom_relief_location_map.jpg

Chapter 2. Iron Age Britain leading up to the Roman conquest

Some archaeological perspectives

The following two chapters give a brief introduction of the evidence we have for society in Britain at the time of the Roman conquest. The first century BC to first century AD sees an interesting overlap in archaeological and historical perspectives; there was no formal writing amongst Iron Age communities in Britain at this time, though there were probably strong oral traditions (Caesar *Gallic Wars* VI 14), so classical descriptions are the first historical accounts of a 'prehistoric' society within Britain. Within the historical texts, significant people, important incidents, colourful stories and those promoting political allegiance and self-interest get reported; impacts on more mundane aspects of life often get generalised or overlooked.

Prior to the impact of Caesar's invasion of Gaul (and subsequently southeast England), it appears that the indigenous (native) and the invading (Roman) societies were run on very different bases. Britain had a largely agricultural economy, built on connections and alliances founded on kinship and possibly a commonality in language; there was no market economy. The metal artefacts which form the basis of this study appear to have been made by specialists out of relatively uncommon materials, using striking design motifs and colours. Their means of dispersal was almost certainly within a gift-based economy, which further imbued them with a significant 'history' (Helms 1993; Jones 2002, 83). These portable objects are seen in many parts of Britain, and they conveyed meanings, now impossible to decipher, amongst certain strata in society as they travelled or were gifted (Foster 2014, 65).

'Celtic Art' as a specific style attributed to many Middle to Late Iron Age objects exhibits similar design motifs, often on restricted artefact types (Garrow and Gosden 2012). Although these objects show some regional traits, they are found in many parts of Britain expressing a degree of unified social and cultural connections and networks. However, the nationally recognisable style of this art crosses the boundaries of areas with distinct regional differences visible through the archaeological record.

An important development in relation to the material culture studied in this thesis has been a large increase in metal detected finds, information about which are now more systematically recorded and accessible through the Portable Antiquities Scheme (PAS) (launched in conjunction with the Treasure Act 1998); this has brought more widely distributed and diverse artefact material to the fore (Worrell 2007). These changes in archaeological practice, means a greater range of data is emerging for the many geographically and culturally distinct areas of Britain.

Below, certain archaeological traits and artefact types are briefly examined to illustrate some of the evidence for regionality and change, especially in reference to, burials, oppida and coins.

Regionality

Cunliffe in his seminal book *Iron Age Communities in Britain,* first published in 1971, recognised that the previous division of Britain into lowland and highland areas by Fox (1932) was significant to the regionality of Britain in the Iron Age. A southeast to northwest divide is not only inherent for the landscape and climate, but also significant for the recognition of archaeological differences and for the establishment and maintenance of contacts within Britain and abroad (i.e. the near continent for the southeast, or the Atlantic seaboard for the northwest). Within this division there were further distinct regional developments.

More recent in depth studies of many regions confirm the influences of landscapes, contacts, resources and exchanges, for example in Norfolk (Davies 1996, Hutcheson 2007), the Severn Cotswold region (Moore 2006), Wessex (Sharples 1991, 2010), Yorkshire (Giles 2007,2012) and south Wales (Gwilt 2007). These detailed regional studies show complex pictures of diversity and conservatism, as well as an internal momentum towards change, which followed a further accelerated trajectory within the south of England associated with continental Europe and Rome.

Western and northern areas

Hillforts were the predominant visible settlement type of the western and northern regions, and hillforts appear to have been maintained in parts of Scotland, and especially in the Welsh marches and north Wales into the first century AD. In Wales, aerial surveys and excavations have revealed a range of building types related to farming landscapes of Later Iron Age date, and these are now being regarded as a more common settlement type than the many hillforts present in some areas. In south Wales, Gwilt (2007) writes of the identification of variably shaped enclosures as well as 'univallate and multivallate defended rectilinear and curvilinear enclosures'. Other developments by the indigenous people in western and northern areas also took place; for example the development of brochs, duns and souterrains in Scotland.

In the north and west, different rates of change and conservatism are very evident; they appear to have developed in a manner less reliant on and less influenced by Gallic and Gallo-Roman traditions. These areas of Britain remained without coins, there was still a lack of easily recognisable burial rites and relatively little wheel thrown ceramic; it is also these regions which conducted more protracted resistance to the Roman army. Much of the literature on smaller settlements at this period is poor compared to other parts of Britain. However, there are visible signs of social stratification, mostly seen through change and development expressed by an indigenous elite material culture. There are however also significant problems in assessing some of the archaeology from this period; as Hill points out: 'The archaeological record is biased toward enclosed sites which are more visible compared with unenclosed settlements. In some areas and in some centuries, unenclosed settlements were the norm' (Hill 1995, 58). Enclosures are only a feature of certain areas and periods and much easier to identify, excavate and study.

Southern and eastern Britain

It now appears that there were strong internal impetuses to social change within many parts of Britain from the Middle to Late Iron Age. Many of the studies cited above imply a degree of social upheaval was occurring over much of southern and eastern Britain before as well as at the time of the Roman invasion, and not only within areas directly influenced by Gaul, or indirectly by Rome. In particular, for much of England, there seem to be transformations cutting across traditional ties of kinship and shared beliefs in communities, and a move towards personal power, land ownership and the importance of ancestry and individualism. These various and varied changes help give some insight into the adoption of Roman practices, and later, Roman rule; but also shed light on northern and western regions where conflict remained bitter and protracted (Hill 2007, 16-40).

The manner in which settlements changed could indicate how societies were becoming re-structured in themselves. Giles notes that by the 2nd century BC in East Yorkshire, roundhouses became clustered in small groups and were repeatedly built on the same spot 'a reiterative act which served to remind people of the household's association with a particular place' (Giles 2007, 240). These settlements also had fewer entrances and boundaries were marked out, in contrast to previously more open settlements. She suggests clusters of houses express society's concentration on kinship and family rather than larger communities, in itself implying that ownership of land and the marking of territory signal less reliance on communal labour and mass storage of crops. There is also the appearance of marked boundaries and field systems (Giles 2007; Moore 2006).

A significant occurrence in various areas of Britain was the proliferation of smaller settlements (Hill 2007, Giles 2007); and the appropriation and use of previously less inhabited land for settlements (Davies 1996; Hill 2007; Moore 2006), and in other regions the agglomeration of people into larger 'oppida' (see below). Hill infers that this expansion and increasing permanence of settlement was a result of population increase, and those moving to previously less inhabited land were 'more open to agricultural innovation'(Hill 1995, 61-2) and to the manufacture of specialist craft activities.

Theories of social change seen through the use of settlements and developments in land use in Wessex have been explored in depth by Sharples (Sharples 2010). This area in the southwest of England is historically well excavated and surveyed, and has an impressive monumental landscape seen through a series of large hillforts, for example Danebury (Cunliffe 1984; Cunliffe and Poole 1991 etc.), Maiden Castle (Wheeler 1943; Sharples 1991) and Hambledon Hill (RCHME 1996). Excavations have also taken place at other settlement types such as Gussage all Saints (Wainwright 1979), Winnal Down (Fasham 1985) and Little Woodbury (Bursu 1940). Good bone preservation and environmental data, as well as structures and finds have provided a relatively large amount of evidence for this area, through which social relations between communities and strata of society can be studied in depth (Sharples 2010). In the Middle Iron Age the large developed hillforts were predominant in the area and smaller ones were abandoned (Cunliffe 2000, 166). The enlarged ramparts were constructed and maintained by time consuming and labour intensive communal work 'creating physical links between the landscape, its inhabitants, and the monuments' (Sharples 2010, 118). In the Middle to Late Iron Age settlement patterns became far more diverse, with an 'increasingly complex agricultural economy' (Sharples 2010, 77), which was also reflected in the increasing importance of material culture and exchange.

Rome and its influence

Rome was a military machine, establishing an imposed set of rules which tied people together, such as taxes, Latin, military equipment and discipline (Mattingly 2006). Rules were imposed by the imperial regime in order to exploit the resources of this peripheral part of Europe for personal prestige and wealth. It aimed at creating a system that generated new land for veterans, new material resources for a market-orientated society and positive propaganda for Roman leaders such as Julius Caesar, Claudius and other Emperors who needed to establish their legitimacy and popularity.

The South East of England was the area most affected by the Gallo-Belgic and Roman influences before the conquest. Here a far more hierarchical society was establishing itself in the first century BC, with the formation of distinctive types of burial, the use of coins (see below) and with the identification of historically named individuals. Dio Cassius, commenting on Caesar's invasion of southeast England states that 'The Britons were not free and independent, but were divided into groups under various kings' (Dio 20, 2). This area was relatively prepared to take on Roman mores and administration; the individual wealth of important and Romanised Britons is attested through the buildings of towns and villas, and an enormous increase in the quantity of Roman and Romano-British material culture. A possible exception to this within the south east were the Iceni, whose adoption of Roman practices seemed slow compared to surrounding groups. An example of this in terms of material culture is given by Martin who 'has drawn attention to the high number of ornamental horse harness fittings in north Suffolk and their associations with Icenian territory (Martin 1988, 68). Davies argues that the horse gear is distinctly Icenian (and Iron Age) in contrast to the Romanised finds present in Trinovantian Suffolk (Davies 1996, 71).

To the west and northwest, many civilian 'Romanising' developments are much more difficult to see prior to the conquest, but after it there are a huge number of relatively long-lived Roman military fortifications (Jones & Mattingly 1990). The northern and western areas were treated harshly by Rome for not complying with their dominance and mores (Mattingly 2007); these regions had less clearly defined political structures and leadership, and the Romans had greater difficulty conquering and keeping them acquiesced. Within mid and north Wales, settlement patterns did not change substantially apart from the abandonment of many hillforts, and for the establishment of Roman forts, and settlements associated with mining communities (CPAT).

Burial

Burial is often one of the most obvious social practices visible in the archaeological record, and a focus for ritual activity, but is largely missing for most of the Iron Age in Britain, except for the Yorkshire burial tradition dating from the fourth to third centuries onwards. However, some regions saw a move towards more formal burials in the Late Iron Age (Hill 2007; Moore 2006; Sharples 2010; Giles 2007).

This is most easily seen in the southeast, where a distinctive cremation rite emerged at the end of the second and beginning of the first century BC (Aylesford-Swarling cremations in cemeteries). This became widely practiced in Kent, Essex, Hertfordshire, Bedfordshire, Hampshire and into Suffolk and Cambridgeshire. These burials related directly to important and rich individuals who were buried with indigenous and imported grave goods. This was buying into a new system in terms of materiality, but was also a means of marking the ownership or right to land; those burying the individual could be seen as venerating their own ancestors. A chronological development within these burial customs is witnessed by examination of the grave goods at Baldock (Garrow and Gosden, 244), containing amongst other objects fire dogs and a cauldron, compared to the later ones at Stanway, containing many personal items such as brooches and imported high class ceramics (Crummy *et al.* 2007). Conversely, within these areas, communal acts of deposition of metalwork hoards generally did not occur in the Late Iron Age. Although not central to this study, the wealth of evidence from this region provides a comparable basis on which to look at other areas. There is clearly a contrast between regions with the most continental contact in relation to those slightly more removed from such influence.

Within Wessex, the selective deposition of some human remains, often fragmented or partial (Sharples 2010, 251), within the settings of an enclosure or hillfort, and often in pits or ditches (Hill 1995), meant that individuals 'were dissipated into a generic body of ancestors' (Giles 2007, 247) within the settlement, so elevating the importance of the community rather than the individual or their family. However, this area also witnessed a change in burial practice in the first century BC. In Dorset (Sharples 2010, 273), crouched and extended inhumations are seen in areas set aside as cemeteries, and discoveries at Yarnton in Oxfordshire (Hey *et al.* 1999) suggest burial grounds might be more common than previously thought.

Giles notes an increase in the expression of violence associated with the later burials in East Yorkshire (those dating to the first century BC), with more incidences of violence and the more common inclusion of weapons with the dead. Her thoughts on these practices are that 'it is in the context of these long-term transformations in social relations that we should understand the rejection of communal ceremonies which no longer expressed the interests of its members (Giles 2007, 240).

A further, relatively rare group of burials often referred to as 'warrior' or 'mirror' burials (Garrow and Gosden 2012, 200) appeared in Britain in the first centuries BC and AD. They contained swords and were sometimes paralleled by burials with elaborately decorated mirrors. They seemed to belong to a special group of men and women; buried with significant artefacts and the mirrors (and spoons when present) could be associated with ritual or prophesy.

However, there were still very few burial rites visible in many parts of Britain, including Norfolk, Wales and northern Britain outside the area of the Parisi in Yorkshire.

Deposition and hoarding

Deposition as a broad term includes burying objects associated with interments, as with the East Yorkshire barrows, the deposition of iron currency bars at hillforts (Hingley 1990) or the collection of particular materials such as the moulds at Gussage All Saints (Wainwright 1979), or other fragmented materials including human and animal bones within pits on hillforts or enclosures (Sharples 2010).

The deliberate deposition of metalwork as a ritual practice became increasingly evident from about 200 BC (Garrow and Gosden 2012, 192); unlike other deposits, these occurred away from settlements in both rivers and lakes, and on dry land (Hill 1995, 66; Hingley 1990; Laidlaw 2003). The nature of these deposits ranged in quantity, quality, place and time; some were single events, such as the hoard at Polden Hill, while others, as with Snettisham or Llyn Cerrig Bach were multiple events of deposition. The deliberate amassing of artefacts, many (but not all) of which were high status items made from prestigious materials was a feature of the Iron Age which became even more evident in the first century AD (Garrow and Gosden 2012, 165).

The increase in deposition of Late Iron Age hoards at the time of the Roman invasion, could also be looked on as reaffirming practices and customs associated with earlier Iron Age traditions of deposition, in contrast to those made at more formal shrines such as Hayling Island and Harlow which developed into Romano-Celtic temples.

Continental influence: the establishment of oppida

One major visible change in much of England, (though not in Scotland or Wales) was the emergence of large, relatively dominant settlements, collectively known as oppida. Creighton argues that 'The social control of central-southern Britain appeared to be changing. Perhaps we might be moving away from our 'egalitarian' hillforts and towards a landscape managed, ruled and terrorised by new leaders with faithful followings' (Creighton 2000, 17). Many of these settlement types differed from hillforts primarily in their positioning and their use; and the drive towards such a change can be argued for as significant in relation to the changes that ensued in economy, elites and traditional ties.

Although sites named as 'oppida' differed quite widely in size and form (Megaw and Simpson 1984), they had certain characteristics by which archaeologists have linked them together. These include boundaries, both continuous and discontinuous, and relatively large numbers of Late Iron Age finds including brooches, coins and coin moulds and imported pottery. Within many regions there was the introduction of inscribed coins and wheel thrown pottery, and in general a dramatic increase in quantities of material culture. In Norfolk, John Davies thinks it is 'now possible to recognise a number of larger sites which may have performed a similar role to that of oppida' and notes that 'they each exhibit a spread of activity and occupation over a wide area, with more than a single focus and they tend to be situated at confluences of major river systems' (Davies 1996, 78).

Creighton (2000), looking at oppida within central southern England, noted they were constructed on the lower fertile land needed for feeding and watering horses – a necessity for a new equestrian elite. Megaw and Simpson (1979, 374-9) associate them with activities other than agriculture, especially manufacture and trade. There is some evidence on sites such as Hengistbury Head for the manufacture of goods on a larger and more specialised scale which would have involved importing some raw materials. The evidence from other oppida-type sites such as Silchester also reveal that they were located in areas not ideally suited to arable agriculture, and have produced relatively little evidence for cereal production; in fact oppida were generally located at peripheral, agriculturally poor locations relatively lacking in settlement, e.g. Silchester, St Albans and Bagendon. Moore, in reference to Bagendon in Gloucestershire, considers that its 'location away from existing settlement clusters and power centres, such as the major hillforts of the later Iron Age can be explained ….as representing the emergence of new elites, constructing centres away from existing power centres, or marking a new community developing away from the constraints of existing social systems and landscapes' (Moore 2006 151). He also considers their positioning as strategic - at the edge of traditionally demarcated areas and exchange routes. He argues that those settled within these newer Late Iron Age communities were in a sense peripheral to existing social networks and ties, and were 'developing their own dynamic, leading to radical social developments' (Moore 2006, 218). Therefore, people occupying these newer sites were outsiders in terms of location, politics and social networks, and therefore in ties of kinship and established routes of exchange, which allowed development outside traditional Iron Age norms.

Despite all these variations, there is evidence that these areas were heavily influenced by continental or Roman goods and customs; coinage was established, an important aspect of material culture within many areas of southern and eastern Britain.

Food

Developments and changes in societal attitudes can be witnessed through evidence of what people ate, and the vessels they used for consumption; as Hill states, 'food and drink were probably key means to creating and sustaining social relations in all Iron Age Societies' (Hill 2007, 27). Evidence from Middle Iron Age settlements shows the use of relatively large ceramic pots and jars such as 'saucepan pots' (Woodward 1997). Sharples suggests the decoration on these was 'displayed through their use as serving vessels in communal meals' (Sharples 2010, 128); creating a forum in which social positions could be negotiated. The deposition of animal bones in pits also indicates a communal rather than individual use of animal food stuffs.

Patterns of consumption showed changes occurring in southern and eastern regions in pre-conquest Britain. Wheel thrown ceramics (c. 125-75 BC onwards in much of south east England) were now used to prepare and serve food in new ways, with a growing emphasis on smaller rather than communal vessels. As well as the preparation of different food types, metal vessels and exotic foodstuffs such as imported wine contributed to the display of different attitudes, connections and individual wealth (Hill 2007, 26-28). Hill also notes that the lack of such goods and practices in adjacent parts of southern Britain is more likely to reflect internal social choices in those regions, rather than any difficulty in obtaining similar goods.

The consumption of large quantities of cattle and pig at Wessex oppida-like sites such as Silchester and Chichester indicated a change in diet within these settlements, as did the presence of amphora for olive oil and wine. There were also continental imports of fine table wares including cups, plates and beakers; these imply an expression of social change through eating and drinking, often in direct contrast to smaller adjacent settlements (Sharples 2010, 167). In addition, the bone assemblage at Silchester shows that the consumption of cattle was unusually high and that the age of the animals suggest they were brought into the area rather than bred there, indicating some such sites were probably dependent on exchange with traditional agricultural settlements for staple foodstuffs, possibly in exchange for imported Gallic or Roman goods (Sharples 2010, 163-4).

Giles also notes changes in ceramic use in East Yorkshire (Giles 2007): 'a more diverse range of forms was introduced associated with feasting; large vessels for cooking and storage, and smaller drinking cups'. She emphasises that these were not adopted from Rome, they were made locally, and their designs were distinctive and individual (Giles 2007, 242). Like Hill, she also notes the disinclination of this area of Britain to make political contacts and to trade directly with the Roman Empire (Giles 2007, 247).

Coins

Change was also manifested in the deposition, iconography, composition and use of coins, particularly those made of gold. Coins were deposited in 'early' metalwork hoards in specific regions, such as those noted within Icenian territory, (Davies 1996, 84-87), and especially in association with torcs (Garrow and Gosden 2012, 167-8); they are also often found as single coins or as small groups. However, they were not deposited with the type of Late Iron Age hoards studied in the subsequent chapters, suggesting the way in which they were used and perceived in the Late Iron Age had altered. It is notable that Creighton's study of Late Iron Age coins shows a shift in their iconography (from c.20 BC onwards), from the use of abstracted heads and horses, to the more literal portrayal of these features, plus the use of Romanised symbols and images (Creighton 2000). These coins were also inscribed with named individuals; this suggests a political authority willing to adopt or accept a king or long-term leader. The inscription of coins in this manner occurred concurrently with a change in metal colour and composition; a greenish silvery gold colour had been carefully maintained up to this point for the Gallo-Belgic and British series, despite some alteration in the amount of gold, silver and copper that was used (the gold content was steadily reduced over time). With the inscribed coins came the introduction of a new red gold colour; alloys were now made which used more copper and less silver, and this distinctly altered the colour of the metal, which would have been noticeably different to those who had had access to earlier coins, and other gold items such as torcs (Creighton 2000; Cowell 1992; Northover 1992). This adaption of colour and iconography was taken up by the majority of areas producing coins, but interestingly not by the Durotriges in south west England, especially Dorset (Sharples 2010, 316).

This use of coins bears witness to the further establishment of individual authority within a more stratified society; it also enabled particular symbols of authority, probably both religious and secular, to be carried and possibly distributed; a marker and a form of communication not just within one tribal area but also across boundaries (Davies 1996, 83)

Increase in material wealth

In the Early and Middle Iron Age large quantities of bronze artefacts were relatively scarce apart from in the East Yorkshire burials, river deposits and occasional hoards such as Ringstead (Garrow and Gosden 2012, 179-84) and Hunsbury (Barnes 1985). In the Late Iron Age there was a huge increase in the amount of archaeological finds from the whole of Britain, and noticeably in the north and west where there had previously been a significant dearth of bronze artefacts. There was a flourishing tradition of insular 'Celtic' art used on prestigious bronze artefacts, and highly skilled iron working is also illustrated by such objects as the Capel Garmon firedog and Iron Age swords, spears and chariot accessories found at Llyn Cerrig Bach. Such items were presumably manufactured by skilled specialist craftsmen for a specific clientele, which used this material for a combination of gift exchange and to signal further the privileged and influential status of important members of society through traditional Iron Age methods of linking kinships, and displaying power. Named individuals from these areas of western and northern Britain are rarely recorded in the literature; the exceptions are those such as Caratacus who was of aristocratic origin, or Cartimandua, a queen politically allied to Rome. Instead, there seems to be a section of these societies whose social status was demarcated through group use, maintenance and deposition of objects such as horse gear and communal vessels.

General comments

All the factors briefly discussed above show a diversity between regions which included a complex series of internal developments and changes within British societies before the Roman invasions in 43/44 BC; which continued to develop in directions dependent on particular locations and customs across different areas of Britain. The causes and ultimate results might have varied between regions, but there was a notable shift in many areas of Britain seen in several aspects of the archaeological record. For example some of these changes were a response to population increase; this in turn resulted in competition for good land. This in turn could well have resulted in the increased occurrence of localised violence within many parts of Britain; as Creighton comments: 'I imagine the Middle to Late Iron Age transition as a far more violent time, for at least a short while as new forms of authority were established' (Creighton 2000, 20). Other means than force, such as trying to establish rights to use or ownership of land through ancestral entitlement was exhibited in some areas through burial practices, or by asserting the importance of familial rather than communal social gatherings, exemplified through social distinctions and practises, for example by the use of different foodstuffs and table wares, or by forming new alliances and trade networks.

It is within some of the areas in Britain with least the overt archaeological changes in the landscape that hoards were deposited in the mid-first century AD. These areas of deposition may have been chosen for this reason – conveying a neutrality to those contributing to the deposition of the hoards, but such regions may also represent those that had not yet succumbed, and were increasingly unwilling to do so, to the outward aspects of Roman style living.

Chapter 3. Roman invasion: British resistance (55-54 BC; AD 43-81)

Historical narrative

The brief historical account below complements the archaeological evidence cited in the previous chapter, and deals directly with the effects of Roman military contact with Britain in the first centuries BC and AD.

The period during the Roman conquest of much of Britain was one of immense impact. It is the first time that there are detailed historical accounts of peoples in northern Europe, their way of life, and their subjugation through foreign military force. Irrespective of the problems of using historical sources when trying to decipher the impact of Rome on Britain, there are other equally difficult barriers to negotiate when assessing the history of this period. As discussed in the previous chapter, strong regional identities within Britain were developing and altering in response to continental and Roman influence, invasion, assimilation and resistance.

Although Roman historical sources must be read with care, they still are the first written commentaries on British society, and in Caesar's case contain first hand observations. Caesar was a superb general, but more importantly here, he was a consummate politician; his *Gallic Wars* were written for the Roman political aristocracy at a time when Roman Republican institutions were falling apart, and moves were being made by individuals for political and military supremacy in Rome. What Caesar wrote was always motivated by his political agenda.

The principal historical sources for the 1st century AD in Britain are Tacitus (c. 56-117 AD) and Dio Cassius (c.155-235 AD). Tacitus was an astute observer, still highly political and motivated by a dislike of the Imperial system and loyalty to Agricola, but he wrote much less overtly for self-gain, and was able to derive first hand evidence from his father-in-law Agricola (40-93 AD), who was Governor of Britain from 77/8 to 83/4 AD. Dio Cassius was an historian and statesman who wrote a history of Rome from its mythical foundation by Aeneas to the death of Severus Alexander (222-235); it contains useful additional information derived from other unknown historical sources, especially about the Claudian invasion of Britain.

Despite the bias, the rhetoric and the historical conventions used by the Roman historians, it is from their texts that we can gain a relatively accurate chronology of events in Britain, which supply a framework for the Late Iron Age, the conquest and the Early Romano-British period. Some archaeological evidence can be matched directly to historical events such as the sacking of Camulodunum (Colchester) by Boudica in 60/1 AD or the establishment of some Roman forts and towns. However, much of the historical narrative has to be viewed in addition to, rather than in tandem with the archaeological evidence.

Julius Caesar, in his second expedition (54 BC) had established relations with many leaders or kings within the south eastern tribes of Britain, and probably actively encouraged the foundation of dynasties in which he could shape formal alliances. The names of these early Britons and their successors is known through both historical sources and by coin inscriptions. It is well after Caesar's campaigns, and during the reign of Augustus in Rome (27 BC to 14 AD), that coin iconography and gold-metal colour change to a much more recognisably 'Roman' form. Creighton (2000) believes this was a direct result of the nurturing and education of British 'obsides' (the 'hostage' sons of British tribal leaders) amongst the aristocracy in Rome. The establishment of some of the later British coin types parallel Augustus' use of named inscriptions in establishing his own dynasty in Rome. These aristocratic contacts were in addition to political and exchange ties already recognised between Gaul and southeast England and Wessex and the southwest. Change and manipulation of land rights are also alluded to in classical sources where it appears that the demarcation of tribal areas altered between the time of Caesar's expeditions in 55 and 54 BC (Caesar *Gallic Wars*) and those under Claudius in 43 AD (Caesar; Tacitus *Annals*; Salway 1981).

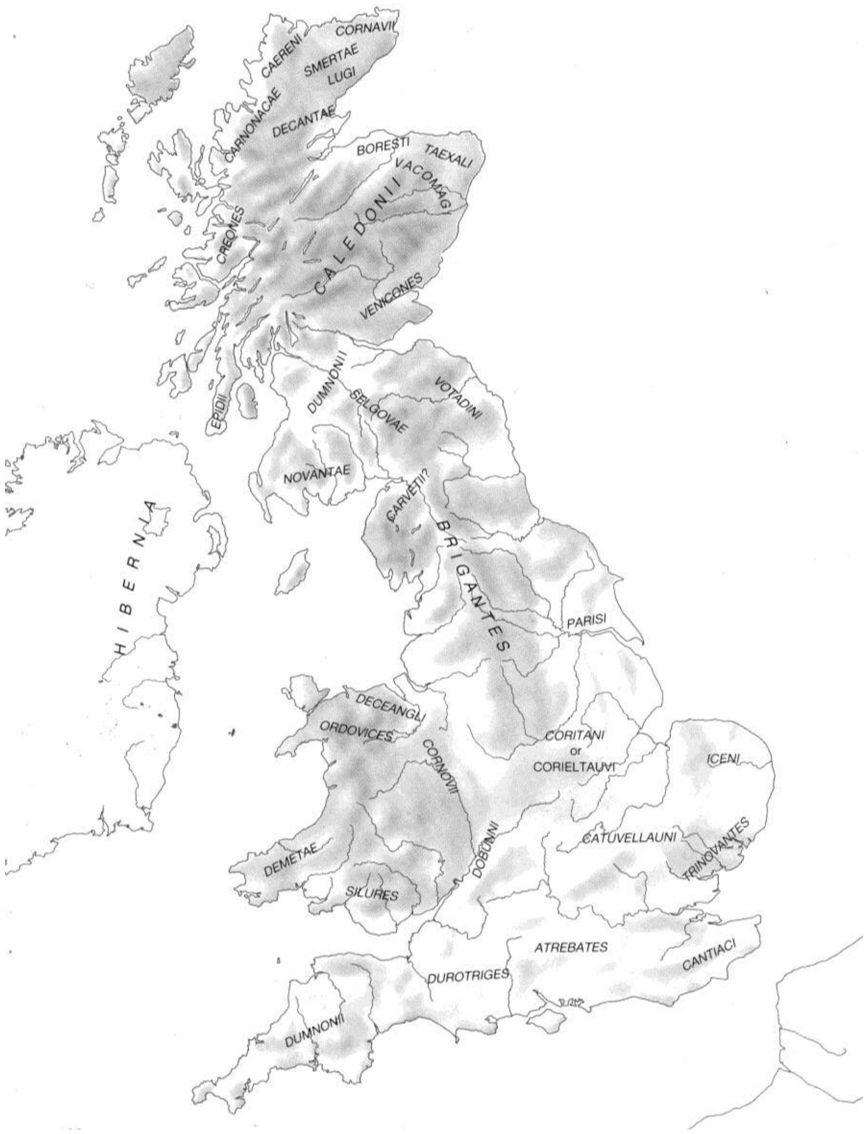


Figure 3. 1: Tribal Society in Britain in the first century AD (Jones & Mattingly 1990, 45).

Following the establishment of client kingdoms in the relatively stable pro-Roman south east, the internal politics of much of the rest of Britain were comparatively fluid during the late first century BC and early first century AD. As has been alluded to, political figures were vying for power, tribal boundaries were changing, and certain individuals were establishing dynastic lines and showing more allegiance to Rome than others (Salway 1981). This was also a time of massive upheaval in Rome Itself, with civil war followed by the total breakdown of the Republican system and the establishment of the imperial Julio-Claudian dynasty.

Both Augustus (27 BC to 14 AD) in AD 26 and Caius (AD 37-41) in AD 40, considered invading Britain, but it was not until Claudius's reign (AD 41-54) that this was undertaken. His personal and political need for military success was paramount in his decision to invade Britain, and it appears that conquest and the creation of a Roman province, rather than the establishment of alliances was his ultimate aim. This invasion was with a view, amongst other things, to win military glory and booty and to exploit the mineral resources of the north and west of Britain. He also needed to colonise land for the settlement of veterans (Tacitus *Agricola*, 12; Jones and Mattingly 1990, Salway 1981).

The archaeological picture on the frontier areas within Britain in the first century AD is dominated by military fortifications; but it is in these areas of western and northern Britain, and at times Norfolk where the native British most resisted Roman annexation, and where symbols of their culture and identity remained strongest in defiance of Roman rule. The areas in which all the large hoards containing enamelled metalwork are found are in tribal regions which were in direct conflict with Rome following the Claudian invasion in 43 AD. It is at this time that the names of tribes and individuals caught up with these disputes are named for the first time in the Roman sources, for example Prasutagus and Boudica from the Iceni, Cartimandua and Venutius from the Brigantes and Caratacus in association with the Silures and Ordovices (Tacitus *Annals*; *Histories*; Dio Cassius *Histories*). These areas suffered harsh treatment after their eventual conquest (Mattingly 2007), but native style artefacts and their deposition in the mid to late first century AD give some insight into the essence of the indigenous population, as a network of influential communities displayed their identity in contrast to Rome.

Much of southeast England and the Midlands accepted Roman rule relatively quickly, and some client kingships were re-established. These included that of Prasutagus (husband of Boudica) of the Iceni and Cartimandua of the Brigantes. It is interesting that both these large and significant tribal areas were within themselves split in their attitudes and allegiance to Rome within the ruling family dynasty; i.e. between the 'pro-Roman' Prasutagus and Cartimandua, and the 'anti-Rome' stance of Boudica and Venutius. However, early on in the Claudian campaign sustained resistance was concentrated in the west and north.

The Durotriges

If we look at the location of the hoards studied in detail in this thesis (those of the first century AD containing 'enamelled' metalwork), similar patterns of resistance emerge. The Polden Hill hoard is from Somerset, at the northern end of the tribal area of the Durotriges. This was an area with massive hillforts such as at Maiden Castle, Ham Hill, South Cadbury and Hod Hill, and a territory that appears to have shown hostility to the Roman invasion. It is likely that they were conquered in the late 40s AD by the legionary forces under the command of the future emperor Vespasian, for which he was awarded considerable honours back in Rome in AD 51 (Suetonius, *Vespasian* 227). Garrisons were stationed at Hod Hill and South Cadbury, and probably others, and a sizeable garrison remained in the territory for a further generation following its conquest (Mattingly 2006, 139). The exploitation of mineral resources here was probably important; 'inscribed lead ingots from the

Mendip hills attest the involvement of Legio II in mineral exploitation and indicate that production was underway by 49 AD' (Mattingly 2006, 139).

The Iceni

Three of the most significant Late Iron Age hoards Westhall and Santon (in Suffolk), and Saham Toney (in Norfolk), were all found within the territory of the Iceni. This tribe initially rebelled in AD 47, when ordered to surrender all arms by the new Governor P. Ostorius Scapula, and were defeated. However, the Iceni initiated the most serious known British rebellion against the Romans in 60-61 AD, after the death of Prasutagus the client king, under the leadership of his widow Boudica. Both the British and Roman warring factions were ruthless, but the battle against Suetonius Paulinus was decisive: 'Our soldiers spared not to slay even the women, while the very beasts of burden, transfixed by the missiles, swelled the piles of bodies' (Tacitus *Annals* IV). The Trinovantes were closely allied to the Iceni, and the land belonging to both these tribes, plus others which had helped their cause or even remained neutral were laid waste; 'whatever tribes still wavered or were hostile were ravaged with fire and sword' (Tacitus *Annals* IV). Tribal areas within the southeast did not rebel again. Roman Policy towards the British after this near defeat and shocking aftermath was evidently altered; a more conciliatory governor, Petronius Turpilianus, was appointed to replace Paulinus, as well as a new provincial procurator (Tacitus *Annals* 14.39).

The Brigantes

There was also early and constant friction from another client kingdom, the Brigantes, ruled by Cartimandua who appears to have led a large confederacy of smaller tribal units, collectively known as the Brigantes. Elements of this tribe were divided in their allegiances, although Cartimandua was pro Roman. Tacitus cites the 'state of the Brigantes, [is said] to be the most prosperous in the entire province' (Tacitus *Agricola* 17)

It is in this territory, near the fortified 'oppidum' of Stanwick, and in the region associated with the rebel leader Venutius (Cartimandua's ex-consort) that the Stanwick/Melsonby hoard was found. There were several episodes of internal strife within the Brigantian tribe, where Cartimandua had to be helped by the Roman army to remain in power. There were minor problems in AD 51-2, when Caratacus was handed over by Cartimandua to the Romans. In both c. AD 56-57 and then AD 69-70 Venutius rebelled against Cartimandua's reign. In the latter revolt, much of the Brigantes were scandalised by her taking up with Venutius's arms bearer Vellocatus. This occurred during the time of civil war in Rome and the eventual establishment of the Flavian dynasty. With many Roman generals preoccupied with events in Italy, Venutius overthrew Cartimandua who fled. A major concerted campaign was launched under the Governorship of Q. Petillius Cerialis in AD 71 to overthrow Venutius. However, it was not until AD 77-8 that the Brigantes were finally pacified under the Governorship of Agricola.

Wales: The Silures, Ordovices and Deceangli

The Welsh Tribes of the Silures, the location of the Seven Sisters hoard, and the Ordovices a region also containing hoards (those of Tal-y-Llyn and Moel Hiradug), showed strong defiance up to their subjugation (Tacitus; Dio). They are continually referred to as fierce opponents to Rome, and were noted especially for their offensive stance under the leadership of Caratacus:

'The army then marched against the Silures, a naturally fierce people and now full of confidence in the might of Caractacus, who by many an indecisive and many a successful battle had raised himself

far above all the other generals of the Britons. Inferior in military strength, but deriving an advantage from the deceptiveness of the country, he at once shifted the war by a stratagem into the territory of the Ordovices, where, joined by all who dreaded peace with us, he resolved on a final struggle and continued to engage in guerrilla warfare for over thirty years before finally being conquered' (Tacitus *Annals* XII).

British-Roman history from AD 43-78 (Tacitus; Dio) has constant references to wars and battles with these western tribes.

'Conspicuous above all in stubborn resistance were the Silures, whose rage was fired by words rumoured to have been spoken by the Roman general, to the effect, that as the Sugambri had been formerly destroyed or transplanted into Gaul, so the name of the Silures ought to be blotted out.' (Tacitus *Annals* XII).

There was a fierce protracted war against the Silures and Ordovicians while under the leadership of Caratacus from c. AD 47-51, after which he fled to Brigantian territory and was handed to the Romans by Cartimandua. Following this, the Silures continued to fight until AD 58 when they were temporarily subdued by the new Roman Governor Q. Veranius Nepos. In AD 61, C Suetonius Paulinus campaigned in northwest Wales in order to subdue the Druidic centre on Anglesey, but had to cut short this campaign to deal with the Boudican revolt. Again Tacitus notes of 'the Silures (that) neither terror nor mercy had the least effect; they persisted in war and could be quelled only by legions encamped in their country'. In AD 74 the Silures were finally defeated by Sextus Julius Frontinus, and the Ordovicians in AD 78 by Agricola. Tacitus states about the latter that 'the tribe was all but exterminated' (Tacitus *Agricola* 36), which even if an exaggeration reflects the extremely ruthless treatment, bordering on genocide, that the Romans were prepared to mete out when necessary.

Scotland: The Novantae

The final hoard studied here is from Middlebie near present-day Lockerbie in Dumfriesshire. This was in the tribal area of the Novantae, which was conquered by Agricola, moving north after defeating the Ordovices and Brigantes.

Although treatment of the Northern tribes conquered by Agricola is not often specified, as Tacitus was intent on portraying him in the most positive manner, both archaeological and historical evidence imply that he dealt very harshly with rebel territories. 'Some persons used to say that he was too harsh in his reproofs, and that he was as severe to the bad as he was gentle to the good' (Tacitus *Agricola* 22). Excavations at Stanwick (the most northerly 'oppidum' in Britain), and the nearby settlement of Melsonby (where the hoard was found) were destroyed and not re-inhabited after the defeat of the Brigantes (Fitts *et al.* 1999). It is likely that Agricola continued ruthlessly with his campaign up into southern Scotland.

Exploitation, slavery and Romanisation in Wales and the north

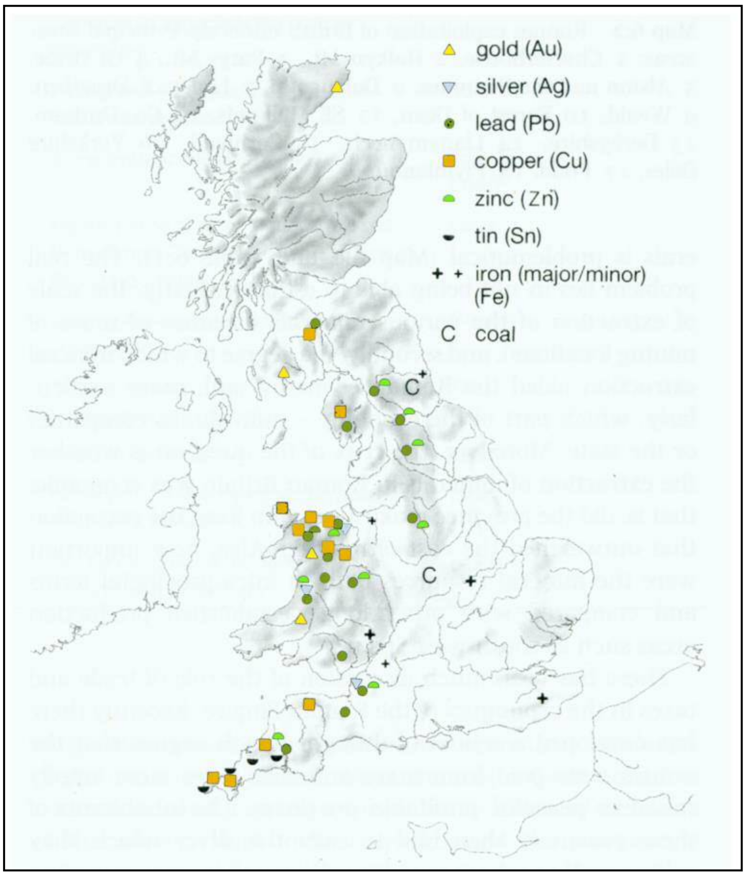


Figure 3. 2: Map of mineral resources of Britain (after Jones & Mattingly 1990, 179).

The map above illustrates one reason why the Roman army was so persistent in pursuing the conquest of Wales and northern England, though less so in Scotland. As Tacitus states, 'Britain contains gold and silver and other metals, as the prize of conquest' (Tacitus *Agricola* 12).

In Scotland, Agricola's attempts at conquest were relatively short lived; he drew a demarcation from the Forth to the Clyde before being recalled by Domitian in AD 84. Later, the northern frontier of the empire was physically demarcated first by Hadrian's Wall, started in AD 122, and then by the Antonine wall in AD 142, which lasted until the 160s before it was eventually abandoned.

Wales and northern England were known to be extremely rich in mineral resources such as copper, lead, zinc and gold. The land itself, in much of the western and northern areas of Britain (Cunliffe 1991), was not rich agriculturally and could not support colonies or the settlement of veterans to the same extent as much of southern and eastern England. However, the ruthless subjugation of the deeply hostile Silures, Ordivicians, Deceangli and Brigantes were worth the protracted wars, not to 'Romanise' the province in the same manner as much of the rest of England, but almost certainly for the exploitation of their mineral resources in as efficient a manner as possible. This was a policy which would have been regarded as even more justifiable to the Romans following native resistance from these regions. It is possible that much of the indigenous population of north Wales was enslaved following their conquest; those defeated in war were a frequent and legitimate source of booty (Wiedermann 1981, 114-115), and one which would have supplied a labour pool for extracting the mineral wealth of the land.

There is evidence that the use of slaves in mines was regarded as a particularly severe punishment 'One area in which slaves were systematically and brutally exploited was mining ... in the late Republic Roman contractors (*publicani*) used slaves for mining under the most atrocious conditions' (Wiedermann 1981, 177).

Diodurus Siculus gives some indication as to how horrific the Romans themselves regarded this form of slavery when writing about conditions in Spain in the late Republic, where a labour force was used to exploit mineral recourses there:

'The men engaged in these mining operations produce unbelievably large revenues for their masters, but as a result of their underground excavations day and night they become physical wrecks, and because of their extremely bad conditions, the mortality rate is high; they are not allowed to give up working or have a rest, but are forced by beatings of their supervisors to stay at their places and throw away their wretched lives as a result of these horrible hardships. Some of them survive to endure their misery for a long time because of their physical stamina or sheer will-power; but because of the extent of their suffering, they prefer dying to surviving' (Diodorus Siculus 38.1.)

If a similar fate was anticipated by native Britons in Wales, it would be unsurprising that their resistance to Roman occupation was so desperate. Mattingly argues that the Deceangli in particular may have been used in a similar manner to Spanish captives and forced to become a major part of the labour force used for mining and metallurgy (Mattingly 1996, 416). He goes on to say that the

'sites that ring the Clwydian mountains from which lead was extracted offer as comprehensive an example as one might wish of the Roman exploitation of a conquered territory possessing potentially lucrative mineral reserves. Lead pigs from the area were stamped 'Deceangli' in the first century, acknowledging just whose lead and silver the Romans were taking. The impact of Roman occupation on the Deceangli thus appears to be largely negative, with their land mostly annexed to military or imperial control' (Mattingly 1996, 416).

North Wales is particularly rich in copper ores, for example from the established mining sites at the Great Orme and Parys Mountain. Similarly, stamped copper ingots also indicate that mining was undertaken on behalf of the state, (Mattingly 1996, 417). It should also be noted that in reference to areas under military or imperial control that 'far from being agents of 'Romanitas', the army constructed its culture and identity to emphasise its power, its difference and its distance from ordinary civilians' (Mattingly 2006, 199). The Tribes of north Wales, for their natural resources and their resistance to conquest, remained one of the least 'Romanised' areas within the Roman Empire.

Administration under Roman rule

The establishment of different types of forts and towns within Roman Britain gives an indication of the status of the regions and their treatment by the Roman authorities.

The highest ranking towns were 'coloniae', principally established and maintained for Roman citizens; the earliest of these was founded at Colchester (Camoludunum) in AD 49; later 'coloniae' were based at York, Lincoln and Gloucester (Jones & Mattingly 1990, 14). 'Civitates' were regional capitals which provided planned administrative centres for local government, plus other amenities within the region. These were made up of magistrates and Roman citizens together with the people occupying the surrounding territory. Most of these centres appear to have been based on old tribal territories, with the 'civitas' capitals usually sited where prominent native oppida had been established such as at St Albans, Silchester and Dorchester. However, there were notable exceptions: in the north and west of Britain and in the territory of the Iceni, 'civitas' capitals tended to be founded away from established native strongholds (such as Stanwick and Thetford). Some regions remained without this type of administration altogether, as in much of Wales and northwest England (i.e. in the mineral rich areas administered by the Roman army). Tribal boundaries appear to have been fluid to some degree up to the Roman invasion, and modern definitions are based on the distribution of coins; no doubt territories were defined further to suit Roman rule. By denying a region a 'civitas' town they were in many respects denying its population Roman legitimacy, even long after its conquest. In such areas, 'the socio-economic stagnation of the Roman period both contrasts with the Late Iron Age developments and highlights the stifling control of Rome and her garrison. Britain's ultimate status as an imperial possession is most clearly delineated in these varied landscapes' (Mattingly 2006, 427).

The type of imposition of Roman administrative rule can be used to gauge the status of many of the areas under investigation in this study. In the region of the Iceni, traditionally prominent Iron Age centres were not promoted as Roman towns, the original 'civitas' in this area is relatively obscure. On first sight it appears odd to have relocated the Icenian centre of administration to Caistor St Edmund under early Roman rule. 'A decision was clearly taken by the Roman authorities to terminate the political importance within Breckland (i.e. established sites at Thetford and Saham Toney) and to focus their administration in the east' (Davies 1996, 88). Most 'civitas' were founded on former Iron Age centres, and this geographical switch of political control could be a result of the Breckland areas being sidelined by the Roman administration following the Boudican revolt (Davies 1996, 88). Another Roman motivation here was to take away control of salt production from the Iceni, and manage this area as imperial estate (Aldhouse Green pers.comm).

Stanwick is interesting as the most northern oppidum known, where high status imported Roman material was found, for example ceramics and glass plus amphorae probably originally containing oil and wine (Fitts *et al.* 1999). However the ceramic sequence shows a relatively short lived period in which these materials were present, which came to an abrupt end coinciding chronologically with the subjugation of the Brigantes by Agricola in AD 77-8. Although possibly a Roman 'civitas' was founded not too far away at Catterick , and there was certainly one at Aldborough to the south; the area around Stanwick was not used as a civil administrative centre, and the Roman legionary base was established at York.

The situation in Wales is attested in the historical sources; as noted above, the Silures had been threatened with entire annihilation by Suetonius Paulinus, and well after they were finally conquered there remained a legionary presence at Caerleon. It was close to this that the 'civitas' of Caerwent was founded. Their bitter resistance may explain the late granting of self governing 'Civitas' status only in the early second century, and perhaps then more for the administration of settled Roman veterans than any real attempt at the general 'Romanisation' of the indigenous population. 'What towns there were (in Wales and the north) reveal a closer relationship with the military network. This has often been explained by the absence of a developed system of pre-existing centres, but recent work has begun to focus on the role of the army itself in promoting or retarding the urbanising process' (Burnham *et al.* 1997).

The legion in south Wales would have occupied a large territory within Silurian land, and the settlement of veterans would have consisted of 'prime farmland and other resources confiscated from the Silures' (Mattingly 1996, 414). In addition, Caerwent was small, founded relatively late, and situated very close to the legionary base at Caerleon. This 'exemplifies the treatment of a native people allowed to pass under civil administration on much less advantageous terms than most other urbanised Romano-British communities' (Mattingly 1996, 412).

The way in which these tribes were subjugated and the lack of any early 'civitas' capital in south east Wales, plus none at all ever established in the very mineral rich areas of north Wales testifies to the status of this part of Britain under Roman rule. The Ordovices and the Deceangli were never granted 'civitas' status, 'the Ordovices developed no towns or villas and, as with the Deceangli, the evidence for wealth accumulation in their territory is reduced to one or two exceptional native settlements' (Mattingly 1996, 417).

It can be seen from historical sources that many of the tribal areas where Late Iron Age metalwork hoards were found were in direct dispute with the Roman army and, even after conquest these regions were treated less favourably in terms of Roman administration 'the extent to which they found themselves disadvantaged by the resources granted them may have promoted resistance however subtle or passive' (Mattingly 2006, 369).

In this context, the exceptional number of hoards with high status metalwork must be seen as a direct response to the Roman invasion of these parts of Britain. The type of artefacts in the hoards, predominantly associated with chariots and feasting and drinking, are suggestive of a native British warrior or tribal elite. In both style and context they are unlike much of the 'Romanised' material culture from this period found in established Romano-British regions, or areas influenced heavily by continental contacts.

This theme of indigenous Late Iron Age resistance seen through both the practice of deposition and by the type of artefacts deposited will be discussed in the chapters about specific hoards. However, one of the key linking criteria in these hoards is the large amount of horse-related gear, usually of copper alloy and sometimes highly decorated, which was selected for inclusion. Chapter 10 will examine the importance and significance of horses in the Middle to Late Iron Age, and what this might reveal about the societies under discussion.

Chapter 4. Copper alloys in the Late Iron Age

This chapter describes some of the previous analytical work carried out on copper alloy artefacts from the Iron Age and Roman periods. Published data has been invaluable in comparing and analysing results from a variety of studies with data collected by the author on Late Iron Age hoards, and on single items from the period which have been found in Wales.

The analysis and interpretation of copper alloys in the Iron Age and early Romano-British period has been carried out on single items, for example the Dinnington torc (Beswick et al 1990); assemblages from particular sites such as hillforts (Northover 1984, 1987, 1991; Barnes 1985); artefact types such as brooches (Bayley and Butcher 2004); and metal items from wider geographical, chronological and typological groups, such as the study of objects from northern Britain undertaken by Dungworth (1996, 1997).

The degree of analysis has also varied; many single objects, especially single items brought in under the Portable Antiquities scheme have only undergone qualitative analysis, or at best semi-quantitative analysis of uncleaned surfaces. This contrasts with Northover's microprobe analysis which provides quantifiable results for trace elements. A common middle ground has been surface analysis on conserved surfaces, or on objects which have been slightly abraded (Bayley and Butcher 2004). This has provided a large quantity of information, but not all of it is directly comparable.

Alloy composition

There are seven major terms used in the following chapters to describe metal and alloys within this study. These are:

- Copper: impure compared to modern copper, with trace elements present
- Bronze: an alloy of copper and tin, containing at least 2% tin
- Brass: an alloy of copper and zinc, containing at least 2% zinc
- Leaded bronze: an alloy of copper, tin and lead, containing at least 2% tin and 1% lead
- Leaded brass: an alloy of copper, zinc and lead, containing at least 2% zinc and 1% lead
- Gunmetal: : an alloy of copper, tin and zinc, containing at least 2% tin and 2% zinc
- Leaded gunmetal: an alloy of copper, tin, zinc and lead, containing at least 2% tin, 2% zinc and 1% lead.

One issue occurring for both the current definitions and with many of the studies cited is that several different parameters are used to describe the copper alloys named above. The parameters used here were decided on by looking at previous studies, modern definitions and natural cut off points, while trying to maintain a relatively simple system: an important factor was whether the alloying metal had been deliberately added or was present as a 'trace element' in the copper.

Some complex definitions have been applied to deliberate additional quantities of tin and zinc present in copper alloys, for example Bayley and Butcher (2004, 14). Hamilton used a more clear cut threshold of two percent or above to define the intentional addition of tin and zinc (Hamilton 1996, 43); this seemed a relatively straight forward classification for use in the present study, especially as it fitted with metal analyses from the Polden Hill hoard, where a couple of brass objects had minor tin contents under two percent (knobbed ring 46, 3-22,106: containing 1.09% tin and 15.39% zinc; and brooch 46, 3-22, 125: containing 1.72% tin and 15.89% zinc), which seemed to be accidental rather than deliberate inclusions. Craddock (1988), also points out that zinc added at two percent acts as a deoxidant making the molten metal more fluid, which helps to produce castings free from pin-holes. So for this study quantities above two percent of both tin and zinc were chosen as the lower limit for significant, deliberate additions to copper in bronze, brass and gunmetal.

For the addition of lead, one percent was chosen; Dungworth used one percent lead as a division for deliberate alloying as 'this reflects the difference between unleaded wrought alloys, and cast alloys'(Dungworth 1997, 6.4). Within the Polden Hill hoard, all the lead present was below one percent.

Methods of analysis from previous studies

Methods of analysis for metals referred to in this chapter include electron microprobe analysis (EPMA), scanning electron microscopy with energy dispersive and /or wavelength dispersive spectrometry (SEM EDS/WDS); X-ray fluorescence spectrometry (XRF), inductively coupled plasma mass spectrometry (ICPMS), proton induced X-ray emission spectroscopy (PIXE) and atomic absorption spectrometry (AAS). For details of methods used for artefacts in this study see appendix 3.

The interpretation of metallurgical studies has also followed different strategies, dependent on the type or collection of artefacts as well as the manner of analysis. Many of these studies have produced invaluable comparative material and demonstrated trends or patterns for particular groups of artefacts.

Intensive chemical analyses on particular groups of material can give unique sets of data which can, in turn, be examined in great detail. However, it is often not possible to undertake this level of work, so analysis has not always taken place in a systematic way. Sometimes small, apparently representative samples of objects have been examined, or small groups of objects published within specialist reports. Some of the most important comparative analyses for this study are discussed below.

Previous analyses and interpretation

Analysis of bronze items by Peter Northover, principally from sites in Wessex such as Danebury (Northover 1984, 1991b), Hengistbury Head (Northover 1987) and Maiden Castle (Northover 1991a) enabled him to develop hypotheses on bronze 'types', based on the presence and quantities of certain trace elements. The vast majority of objects were tin bronze, with lead content below one percent (Northover 1991a). By the early 1990s, Northover felt there were sufficient analyses of Iron Age objects to classify copper alloys by trace elements using arsenic, antimony, cobalt, nickel and silver. From these elements he developed nine impurity patterns, to which he assigned finds in association with context and type, finding consistencies for some metalwork, for example sheet metal from Maiden Castle (Northover 1991a, 160). He found there was no correlation between the tin content and the impurity patterns. Although trace element analysis can be very useful, especially for looking at collections of objects, there are complicating factors inherent in their use, particularly in relation to metal sources, which needs to be recognised. These include the inhomogeneity of ore sources, the effects of smelting and manufacturing processes, and the re-use of scrap metal (Tylecote et al 1977; Northover 1989).

Dungworth produced a further important study of artefacts from the north of Britain dating from the Early Iron Age to the end of the Romano-British period. This covered a range of object forms from a variety of contexts (Dungworth 1997). All copper alloys from the Middle Iron Age were tin bronze; cast objects averaged 11.2 percent tin, and wrought ones 8.8 percent tin, in line with other studies which have looked at Iron Age bronze (for example Northover 1991a/b). Within his study, Dungworth analysed the harness sets from the Stanwick/Melsonby hoard (MacGregor 1962). He described these as ‘Celtic’ metalwork, Iron Age in date, but ‘Celtic’ on stylistic grounds (Dungworth 1997, 5.5); his analyses showed very interesting patterns in the use of brass and bronze, which helped clarify and amend the archaeological interpretation of the artefact sets (Macgregor 1962; Dungworth 1996, 399-422). There was very little addition of lead to bronze objects in the Iron Age prior to the first century AD.

Dungworth also looked at trace elements present in Iron Age and Roman bronze objects to help differentiate material from the two overlapping traditions, but not to the detailed level undertaken by Northover. He found the most useful element was arsenic, which was often present within Iron Age bronze, but rarely in Roman or Romano-British examples, and at a significantly lower level in the latter (Dungworth 1997, 5.3.6). In general, Romano-British alloys were ‘cleaner’, containing fewer trace elements. He put this down largely to the volatility of arsenic and other elements within ores, and the higher smelting temperatures used by the Romans (Dungworth 1997, 6.6).

Cowell (1990) undertook analysis of a large number of both Roman and Late Iron Age artefacts from the early Roman fort at Camerton; the results, in conjunction with Jackson’s interpretation and dating of the material give a valuable insight into near contemporary Late Iron Age and Roman artefacts from a single site in Britain, some military and others domestic.

Jackson argues that 90 percent of the copper alloy artefacts recovered in this hoard would have been in circulation in the mid first century AD. The material is what would be expected from a Roman fort, and could be part of a ‘conquest-period military assemblage’ (Jackson 1990, 19), probably left as ‘a “closure” deposit, a collection of scrap cleared from a workshop or store and buried prior to the departure of the garrison’. This could have been buried if it was impossible to remove everything when leaving the fort, either with a mind to later retrieval or to prevent the metal falling into enemy hands (Jackson 1990, 21). As with some of the hoarded material, it showed signs of wear and damage.

All the copper alloy objects from the Camerton hoard were analysed qualitatively (XRF), and a proportion of both Roman and native style material was also analysed quantitatively (AA) (Cowell 1990). The material was categorised as either ‘military’ or ‘domestic’ and ‘Iron Age’ or ‘Roman’.

Assessment of the analytical data shows patterns not dissimilar to the Seven Sisters hoard (Davis and Gwilt 2008). All the Iron Age material is of unleaded cast bronze; (average tin content 9.8 percent). These artefacts are also all associated with either horses (chariot/cart) or with vessels (three tankard handles). The Roman material, by contrast, is made from copper, leaded copper, bronze, leaded bronze, brass, leaded brass, gunmetal and leaded gunmetal. However, ‘within the Roman group there is a marked preference for artefacts with military applications to be manufactured from brass and this is particularly true of the armour fittings’ (Cowell 1990, 76). It is also these objects that tend to be decorated with silvering, tinning and niello.

Of further relevance to metalwork at this period is the comprehensive analysis of Romano-British brooches, mainly from Richborough, but including a range of comparable items from other sites, by Bayley and Butcher (2004). This makes a detailed assessment of typology in conjunction with metallurgical composition. The majority of artefacts were analysed on cleaned surfaces using XRF, and draws on the three main constituent alloying elements added to copper: tin, zinc and lead to undertake detailed analysis of the type of alloys used throughout the Romano-British period. The analyses address changes and developments in the alloys, the brooch types, methods of manufacture and the style of applied decoration.

Bayley and Butcher's work illuminates some important patterns in metal use in the Late Iron Age and early Romano-British period, which are reflected to some degree in the composition of the Late Iron Age hoards. The increase in availability of metal, and the ubiquitous nature of brooches in the first century AD (and onwards) means that changes in alloy types and casting techniques for these objects can be assessed and compared more readily than many high prestige Late Iron Age or Romano-British objects from the same period.

In the first half of the first century AD brass objects were imported from the continent, and this alloy started to replace bronze which had been used throughout the Iron Age. For example, one piece 'Nauheim derivative' and 'Colchester' brooches were present in Britain before and after the conquest, and many are contemporary with the Late Iron Age hoards studied here. The Nauheim derivatives show two clear compositional groups, of brass and bronze (the bronze has a few outliers containing small quantities of lead). The Colchester brooches were mostly brass and none were leaded; similar patterns are seen in other types of brooch from this period. There is no evidence for the manufacture of brass objects in Britain before the conquest, but from then on it is possible that brass sheet and ingots were imported (Bayley 1990, 13). Brass technology seems to be brought in by the Romans and early occurrences are strongly linked to Roman military sites (Bayley 1990, 21).

In the mid to late first century AD, there is another technological change. The initial use of either bronze or brass is followed by a greater mix of alloys, with the addition of lead, usually to bronze; indeed 'leaded bronze is a very characteristic British alloy in the later first and earlier second century' (Bayley and Butcher 2004, 210). This coincides with the change from wrought one piece brooches to the adoption of two piece brooches, where the spring is made separately. These latter brooches could be cast in piece moulds which made their production quicker and the addition of lead helped the casting process by improving the flow of the metal (c. two percent). However, the addition of large quantities of lead, way beyond what was required technologically, probably points to economic advantages, as well as to the ease and speed of manufacture in relation to the relative mass production of such items. The majority of Colchester brooches were leaded bronze, Bayley and Butcher state that 'non-brass Colchester brooches from Richborough may represent the early products of this period of experimentation and change' (Bayley and Butcher 2004 149).

There were also other changes occurring; in the early to mid first century AD, the average zinc content in brass brooches was 17 to 20 percent zinc, with no deliberate addition of lead or tin. By the later first century AD, the zinc content averaged, 11 to 13 percent zinc, with one to three percent lead or tin; this implies recycling of metal rather than the use of newly acquired brass. Gunmetals were also used.

Metallurgical analysis has been undertaken on all the copper alloy items from the Llyn Cerrig Bach assemblage from Anglesey (Macdonald 2007). The items in this collection were deposited in a lake over a long period of time, possibly from the third century BC, to as late as the second century AD (Macdonald 2007, 168). The assemblage consists of a range of bronze artefacts, many of which were decorated, and prestigious iron objects including swords, spears and chariot tyres. There are also some composite items such as bridle-bits. The analysis was undertaken using a range of methods: EPMA (Nothover unpublished), ICPMS, SEM EDS (major elements) and SEM WDS (minor and trace elements) (Anheuser et al 2007, 199-206). All the copper alloy artefacts are bronze, except for one sheet fragment of brass (zinc content 26.24). The analyses showed very little consistency between some object types, such as bridle-bit components and terret rings, but did show a pattern of negligible arsenic levels in all the casket ornaments, the majority of the coiled mounts and the nave hoops. Independent assessments of the casket ornaments and coiled mounts have dated these to the early Roman or 'post conquest' period (Macdonald 2007, 115, 149). In this respect the Llyn Cerrig Bach material conforms to Dungworth's use of arsenic levels as an indicator of Iron Age or Roman origin.

There have also been studies of continental material spanning the relevant time frame, which give an insight into the metallurgical traditions of Late La Tène, Roman and Gallo-Roman use (e.g. Beck et al 1985). Unfortunately relatively few objects are of Iron Age date have been analysed, the majority have been classical statuary and figurines, plus some vessels and brooches. Many of the objects were from museum collections and poorly provenanced (Hamilton 1996, 19-21).

The most useful study of continental copper alloys of relevance to this thesis is the work by Hamilton on copper alloy artefacts from the Titelberg, which were excavated from well stratified layers (Hamilton 1996, 36). The Titelberg is a large flat-topped hill in south west Luxembourg which was the location of a continental oppidum, occupied from the third century BC, through the conquest (58-51 BC) and throughout the Gallo-Roman period. It is believed to have been occupied by the *Treveri* in the Late Iron Age (La Tène D).

Hamilton undertook analysis of 120 objects using PIXE, these dated from the second century BC until c. AD 300, with the majority dating from two contiguous periods: 50-1 BC, and AD 1-70 (Hamilton 1996, 39). In her study, she classified the objects using major alloying components into seven groups (copper, bronze, brass, gunmetal, plus the latter three with additional lead), and assessed composition by object type, metallographic structure, and date (Hamilton 1996 14). Of most relevance here is that from the middle of the first century BC to the middle of the first century AD, large quantities of both bronze and brass objects were produced. Brass was first produced in quantity at the site in the first half of the first century BC. Leaded bronze was present from the earliest period analysed (second century BC) and lead continued to be added to bronze, and then occasionally to brass; towards the end of the Gallo-Roman period it was increasingly added to gunmetal. For the period covering 50 BC to AD 70, approximately 18 percent of the alloys were leaded (Hamilton 1996, 44).

Trace element analysis showed that arsenic levels were highest for the pre conquest phase (middle of the first century BC for this area of Gaul), reflecting what Dungworth found in the Middle to Late Iron Age periods in northern Britain. Hamilton also found that distinct trace element patterns were able to show that separate copper ore sources were used for the production of bronze and copper objects and for brass ones (Hamilton 1996, 12).

Brun and Pernot's study of European La Tène opaque red glass included PIXE analyses of the major alloying elements (copper, tin and lead; no zinc was detected) of the metal substrates of twelve of the objects (Brun and Pernot 1992, 247). Eleven of these have lead levels at two percent or above, indicating deliberate addition, with the majority containing over 20 percent. The analyses were from a variety of object types and dates; they also covered objects where a range of techniques had been used to apply the glass. They believe that leaded bronze would cause less cracking by differential expansion and contraction of the metal and glass, and that 'the choice of the leaded bronzes corresponds to a classical choice for cast artefacts' (Brun and Pernot 1992, 249).

Metallurgical relevance to the Late Iron Age hoards

The studies cited above are not exhaustive, but do show some interesting trends for both major alloying components and trace elements, as well as some important differences in the use of metals in Britain and on the continent.

The most significant technological change is witnessed by the introduction of brass; its mass production was first achieved in the Roman world in the first century BC, and it was initially used for the production of coins in the early Empire under Augustus. Brass initially seems to have entered south east England from Gaul, mostly in the form of brooches early in the first century AD, but as with the use of lead, it was more significant after the conquest.

The technological significance of brass lies in its manufacturing process; zinc ores are relatively common but the metal cannot easily be produced without some form of distillation process. However, some smelting procedures using copper and zinc ores seem to have produced early brasses which were perceived as highly exotic. There are a few such examples from the middle of the first millennium BC, known both through analysis of the metal and through classical literary sources (Bayley 1988; Craddock 1988), and it is likely these pieces originated from zinc rich ores in the Near East. However, it was not until the first century BC that the cementation process became established (probably also originating in Asia Minor), which allowed for the mass production of brass. This technology was spread by the Romans throughout Europe.

The cementation process required that ground copper was heated with zinc ore in a reducing atmosphere; a temperature needed to be reached for the zinc to volatilise, but for the copper not to melt. The gaseous zinc then reacted with the large surface area of the copper to produce the alloy brass. If this method of production was undertaken efficiently, a brass containing up to 28 percent zinc could be achieved. The relative volatility of zinc when brass was re-melted meant that the quantity of zinc in early brass was readily depleted (by as much as 10 percent) (Bayley 1988). This reduction can give an indication of how much subsequent re-melting and reworking of the metal had taken place.

In Britain, the first objects made from brass may have used ingots imported to Early Roman military sites (Bayley 1990, 13); but away from these it is probable that melted down Roman artefacts and coins were used. Zinc minerals are relatively abundant in Britain, and once the cementation process was learnt, brass could have been produced in several areas, especially in the north and west;

however, there is some debate as to whether this was the case (Dungworth 1996; Bayley 1990, 11), as there is no direct evidence for either mining zinc ores or processing them to make brass.

Another important factor in British Iron Age metals was the almost total exclusion of lead: the addition of a small amount of lead to copper alloys helps in the production of cast items by reducing the melting point and increasing fluidity, and so reduces the chances of producing flawed casts. Leaded bronze was used extensively in the Late Bronze Age (Northover 1982; unpublished data, National Museum Wales), often with very high quantities of lead. Dungworth found lead incorporated into bronze from the Late Bronze Age to Early Iron Age transition period, but rarely with levels above five percent (Dungworth 1997, 5.2). However, in the Middle to Late Iron Age in Britain, the deliberate inclusion of lead was rare; Dungworth found only a small number of items with over two percent lead, and all contained less than five percent (Dungworth 1997, 5.3.3). This is in contrast to continental Europe, where leaded bronze appears to have been used regularly in the Iron Age, especially for cast items (Hamilton 1996; Brun and Pernot 1992). It seems that leaded copper alloys were only regularly used in Britain when Roman influences became more apparent within the material culture of the first century AD. Leaded bronze appears to have been used to make the weight included in this study (from Santon 1897.222C, chapter 8), which seems a specific and appropriate application. Brooches also provide evidence for the early use of leaded alloys as manufacture switched to the mass production of identical brooches using templates and piece moulds (Bayley and Butcher 2004, 121).

Recent work on Early Bronze Age copper and copper alloy objects (Bray and Pollard 2012) has shown the importance of trace elements to determine likely provenance and movement of these artefacts, through the presence, absence, and depletion of specific trace elements, especially arsenic, antimony, nickel and silver. Arsenic in particular is depleted through smelting and recycling, whereas silver and nickel are less susceptible to loss. The presence and or absence of these trace elements in many of the objects analysed from Iron Age in Britain, could provide important information for provenance and the movement of copper alloys from Britain and Europe in the future, although the data set at present is relatively small. Although no attempt has been made to provenance ores or assess degrees of re-use in this study, trace elements have played an important role in assessing objects from individual hoards to understand on what level the objects may or may not be 'related'.

The use of unleaded bronze in Iron Age Britain, and the presence of relatively high levels of trace elements such as arsenic, and to some degree antimony, suggests a complete break from Late Bronze Age metalworking traditions, with the use of newly mined and acquired copper, rather than metal which has been regularly recycled; both copper and tin ores are present in Britain. During the Early Iron Age there was also a switch from piece moulds to one off casts using investment moulds. This shows that 'insular' customs of metal use as well as style and design had become firmly established by the Middle Iron Age, prior to the highly developed insular styles of the first centuries BC and AD.

Chapter 5. Glass: its composition and manufacture

Early glass making

There are several approaches to the investigation of the technology and production of early glass. These consist of the increasingly accurate scientific analysis of glass artefacts, (mostly elemental composition and isotopic analysis (Degryse and Schneider 2008); archaeological evidence from the presence of glass working sites and the appearance and provenance of objects (e.g. Freestone and Gorin-Rosen 1999); ancient texts, the most extensive of which are Mesopotamian cuneiform texts preserved on clay tablets (Oppenheim *et al*. 1988) and Pliny the Elder's '*Naturalis Historia*'; and finally by experimental archaeology, e.g. Roman glassmakers Mark Taylor and David Hill.

A stable and workable glass is made from three essential ingredients: silica, which is the *glass former*, and the main constituent; an alkali such as soda or potash, which acts as a *flux*, to lower the melting point of the silica, and thirdly a stabiliser such as lime, which reduces the solubility of the glass. There are various ways in which this range of components was acquired; knowledge obtained through elemental analysis and experimentation has been able to examine many of the changes in composition which have taken place both chronologically and geographically.

Mesopotamia and Egypt: origins of early glass in the Near East and Europe

Early forms of glass-like materials, such as faience and Egyptian blue (a synthetic blue glassy pigment of silica, lime and copper, also known as 'frit'), first appeared in Egypt and the near east from the 5th to 3rd millennium BC (Nicholson and Shaw 2000; Peltenberg 1987, 16-20.). Glass was first produced in the 3rd millennium BC in Mesopotamia, in the form of beads and pendants (Moorey 1999) and their manufacture was probably related to the early production of glazes and faience.

From the middle of the second to the early first millennium BC in both the Near East and Egypt coloured glasses were being produced (Shortland, 2003; 2005; Nicholson, 2006; 2007), including minor quantities of red glass. These were initially used to make small items such as beads, jewellery and inlays; then colours such as yellow and blue (though very little red) began to be used to make various elaborate core-formed vessels and alabastroi. Early glasses appear to have been produced by a limited number of specific manufacturers or artisans, under particular patronages. In both Mesopotamia (Oppenheim *et al.* 1988) and Egypt glass was manufactured at royal sites with control over production maintained by elites (Jackson 2005, 1752).

There was potentially a wide variety of silica sources available derived either from crushed quartz or sand; analytical and textual evidence for early glasses from the Near East implies relatively pure mineral quartz was used rather than sand (Brill 1988, 109). Brill, from the analysis of early Mesopotamian texts, believed quartzite pebbles combined with halophytic plant ash were used, and this combination worked well for his experimental glass smelting (Brill 1970 109 128). However, there might have been a larger variation for the sources of silica used in Egypt (Henderson *et al*. 2010) including specifically sourced sands (Turner 1956, 282; Nicholson 2007).

For early glasses, the alkali flux derived from halophytic plant ash contained soda, potash and magnesia, plus a variety of other compounds such as phosphates (Brill 1970; Shortland *et al.* 2006 522; Freestone 2006, 202; Tite *et al*. 2006). Such plants can be found in both desert and coastal environments. ‘The harvesting of plants to produce ashes has a long history in all parts of the world, and they were used for medicinal purposes and in the production of detergent as well as glass making' (Freestone 2006 202). Specialised knowledge of plant types, and recipes for producing appropriate alkali ingredients would be needed, as would the know-how of experts in its preparation and use in glass. In Egypt it is possible that some evaporitic mineral salts were also added to early glasses, though not to the same systematic level used from the second half of the first millennium BC onwards; the detergent and medicinal properties of these salts were also known, and were used in embalming processes (Turner 1956, 283).

A flux was necessary to lower the melting point of the silica to a level where molten glass could be achieved and manipulated. Brill's experiments showed that an initial temperature of about 900°C was needed to combine silica with plant ash to form a partially reacted frit, followed by a second heating (described in Mesopotamian texts) which would need to reach at least 1050-1100°C, at which temperature he produced a high quality glass (Brill 1970, 112). Analysis of early Egyptian glass from Qantir-Piramesses (Rehren and Pusch, 2005) has shown a similar two stage process was taking place there in around the 13th century BC; 'The initial melting of the raw materials to semi finished glass was done at temperatures of 900 to 950°C, followed by coloration and ingot production at 1000 to 1100°C' (Rehren and Pusch 2005, 1756). Brill describes this as 'a sound glassmaking procedure which would accomplish first the pyrotechnological step of starting the quartz-alkali reaction and would clear the system of most of the gaseous reaction products'. The resulting frit would be ground up to aid the higher temperature part of the process, which was 'to complete the melting and reaction and reduce the system to a glass' (Brill 1970, 118).

A third desirable component needed for the manufacture of stable glass is calcium in the form of lime, typically at levels of 5-10%: this acts as a network stabiliser and reduces the solubility of glass (Henderson 2000, 28; Freestone 2006, 206-7). Although lime can be obtained from limestone and shells, there is little evidence for its deliberate addition to early glass. Lime occurs naturally, as with other alkalis, in plant ash which means that for early glasses additional lime was not necessary, and that a flux derived from plant ash, rather than mineral soda, would have been a better choice for glass made from ground quartz or lime-free sand (Freestone 2006, 206-7).

Less than about four percent lime would usually produce an unstable glass vulnerable to moisture (Freestone 2008, 90). There are a few glasses which have survived with relatively little lime and these mostly date to the mid to late second millennium BC. For this period there is some evidence that mineral soda without plant ash began to be used; as Reade *et al.* state 'much of the evidence for this nascent glass tradition is likely to have disappeared due to chemical instability' (Reade *et al.* 2009, 53).

New developments: mineral flux in glass

In both the Mediterranean and the Near East considerable changes in glass making occurred from about 800-700 BC, following the Mediterranean 'Dark Ages' (Bimson 1987). The most significant of these was the introduction of a mineral flux such as natron, rather than the use of halophytic plants or mixed alkali fluxes. This change did not occur universally at first, and a variety of compositions continued to exist showing an evolving transition to this technology (Towle and Henderson 2004), which went on to become predominant throughout the whole of Europe for the second half of the first millennium BC and throughout the subsequent Roman period. 'By the 5th century BC, natron was the flux used in the great majority of glass produced west of the Euphrates, and fed the prodigious growth of glass production during the Roman period when natron-based glass spread throughout Europe' (Tite *et al.* 2006, 1284).

This major change for the source of the stabilising alkali component in glass was noted by Sayre and Smith (1961); they observed that soda-lime-silica glasses fell into two main categories: those with a high potash and high magnesia content (as with the early Mesopotamian and Egyptian glasses dating to the first half of the first millennium BC), which was the result of using plant ash fluxes, and those with low potash and low magnesium values which tended to contain a mineral (natron) flux.

Natron (trona) is a combination of sodium salts, particularly hydrated sodium carbonates, and occurs as a natural evaporite on the shores of desert lakes such as Wadi Natrun in Egypt (Shortland 2004, Shortland *et al.* 2006). It is probable that the majority of natron used for the manufacture of early glass came from Wadi Natrun and al-Barnuj, also in Egypt (Shortland *et al.* 2006, 527). In Europe, natron-based glass displaced not only plant ash glass imported from the Near East, but also that made by industries such as those previously responsible for producing potash-rich and mixed alkali glasses in Italy (Shortland *et al.* 2006, 523) and elsewhere in northern and Western Europe.

With the introduction of a large and reliable source of alkali came the need to source the other ingredients with equal care; mineral soda contains minimal lime, so this stabilising component needed to be obtained from elsewhere. Freestone has looked in detail at both historical sources (Pliny the Elder), and used strontium isotope analysis to suggest how this was achieved (Freestone, 2006; 2008).

He cites two models, which are not mutually exclusive. The first is the deliberate addition of lime in the form of 'shells and fossil sand' mentioned by Pliny in a list of materials which could be added to glass (Pliny 36, 66). The second source is backed by both Pliny and the chemical analysis, and suggests that Levantine sand, particularly from the mouth of the river 'Belus' (modern River Naaman, which runs into the Bay of Haifa), was an ideal source for sand in glass due to its relatively high concentration of lime and relative lack of iron (Freestone 2008). Other sources, exploited under the Roman Empire, are also cited by Pliny (36, 66) and have been investigated (Freestone 2008; Degryse 2008; Brems *et al*. 2009). The possibility of their use is part of a major study being undertaken by (Degryse in press); which could be of considerable significance for understanding glass production in the Roman Imperial period and for early medieval glass in western and northern Europe.

Although either lime-rich sand or specific sources for lime such as shells or limestone could have been used, depending on the source of the silica, analysis using strontium isotopes signifies that most glass was made using only silica and a mineral flux, without the deliberate separate addition of lime (Freestone 2006). Plant ash was the appropriate flux when a lime-free silica source such as quartz pebbles were used, whereas when the flux was mineral soda, a quartz sand rich in calcium was employed (Freestone and Gorin Rosen 1999; Freestone *et al*. 2000).

The overall composition of mineral soda-lime-silica glasses remains highly consistent over the Late Iron Age and much of the early Roman period. This consistency allows additional elements within the composition of the glass to be recognised relatively easily; for example, quantities of tin, zinc and antimony above one percent by weight are almost certainly deliberate additions (Freestone *et al*. 2003), as is the addition of more than 0.2 percent manganese (Freestone pers. comm.).

Changes specific to the manufacture of red glass

The manufacture of opaque red glass posed particular difficulties and this glass was manufactured and used in relatively small quantities, often as inlays. There was known to have been contact between the early Mesopotamian and Egyptian civilisations (Moran 1992); glass has been referred to as an import and export in Egyptian texts, so similarities in technological procedures could well have been conveyed amongst elite glass makers, even if raw materials were sourced more locally. This has led to some debate as to whether the glass was produced in one of these regions, and then coloured locally. Trace element analysis has shown distinctions between glasses from Mesopotamia and Egypt, based on elements not related to additional colourants (Shortland, Rogers and Eremin 2007), and that study helps to confirm the development of two independent glass industries at this period.

As with other coloured and opacified glasses, analyses of the base composition of early red glasses from the Near East and Egypt (Freestone 1987; Bimson 1987; Brill & Cahill 1988) show marked inconsistencies (figure 5.1). Their composition shows relatively high, but variable magnesia and potash levels in conjunction with significant soda and lime content, consistent with the use of halophytic plants as a source for the alkali (Freestone, 1987; Rehren 2000; Henderson 1988).There is a lack of consistency in the quantities of both major and minor elements analysed within these red glasses (Freestone 1987; Brill & Cahill 1988).

The colour in red opaque glass is produced by the presence of red cuprite (Cu_2O) crystals within the glass matrix, therefore early glassmakers had to be able to establish and maintain a strong reducing environment in order to prevent the formation of cupric oxide (CuO) which would impart a blue or green colour. There are some examples of red or brick coloured variants from both Mesopotamia and Egypt which date from the 14th to 13th centuries BC, but these very early red glasses are relatively uncommon (Brill & Cahill 1988, 18).

Alumina and lime concentrations are used in Figure 5.1 to show the variation in the composition of early glasses compared to later ones; the quantities of these two elements reflect the raw materials used and provide an initial impression of glass groups (Freestone 2006, 206; 2008, 87). For example, Henderson and McLaughlin (2003) have shown a significant difference in Islamic el Raqqa glasses where the lower alumina content is due to the relatively pure nature of quartz pebbles compared to feldspar-bearing sand, and alumina levels tend to be consistently lower in glasses made with plant ash (Henderson 2005, 670). Lower levels of alumina are present for most of the red glass from Egypt and the Near East compared to the Iron Age red glass examined in this study.

Red glass shows an additional important change to its composition occurring at a similar time to changes in the type of flux used in the first half of the first millennium BC; this was the deliberate addition of lead. Between the ninth and sixth centuries BC lead levels in opaque red glasses rose to about three percent (Freestone 1987; Brill & Cahill 1988), with subsequent levels often significantly larger (figure 5.4). It is from this period that the first instances of high copper/high lead 'sealing wax' red glass first appear (Bimson, 1987, 167; Freestone 1987), although the less bright low copper/low lead versions continued to be manufactured (Bimson 1987, 169). The limited number of analyses undertaken point to high lead red glass first being produced in the Near East (in Iran) rather than Egypt (Freestone 1987; Brill and Cahill 1988).

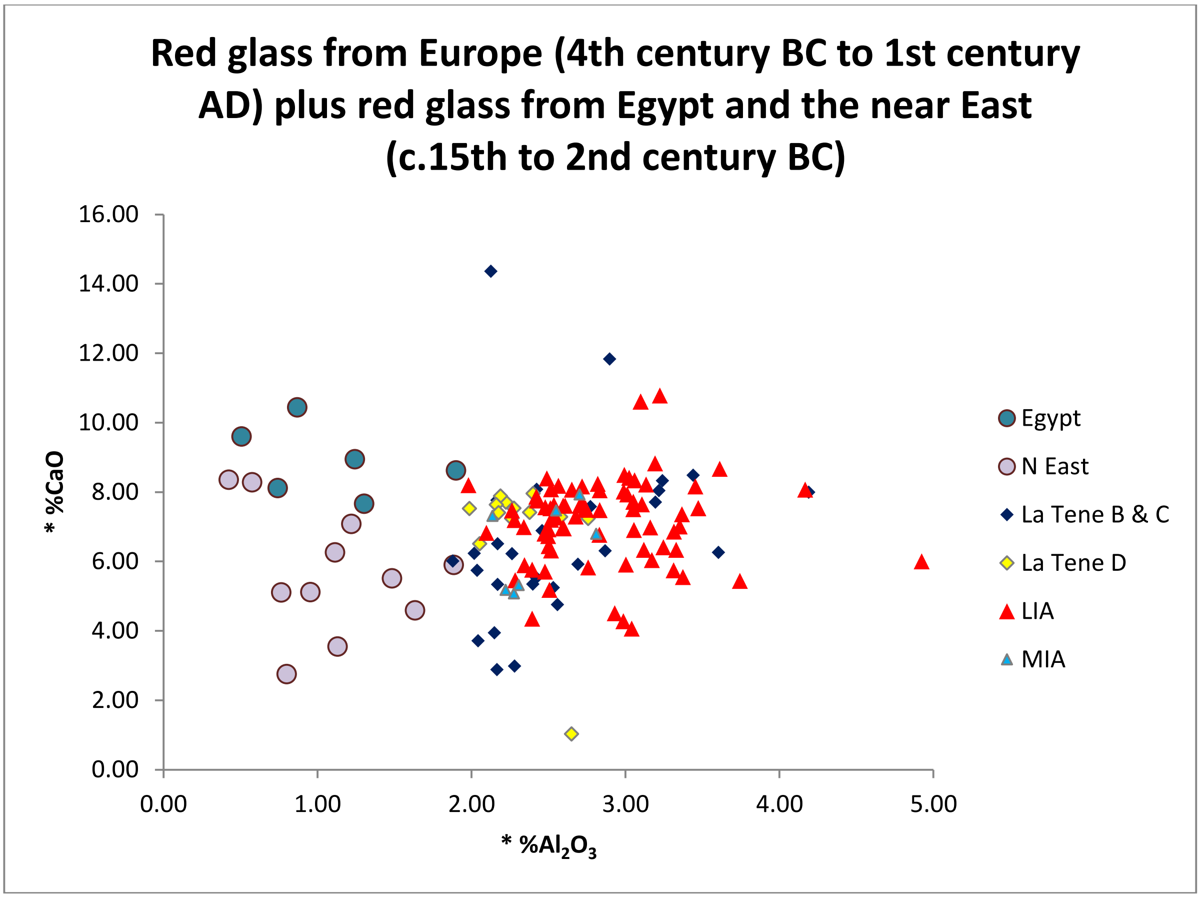


Figure 5. 1: Scatter plot of the base glass composition of early Mesopotamian and Egyptian red glass (circles) and Iron Age red glass, showing a clear difference in alumina levels. (For sources: see appendix 3).[1]

Lead is an element of particular importance to the production of bright red glass. It has several properties which aid both its manufacture and working properties. Within the glass melt it facilitates the solubility of copper and the growth of dendritic cuprite crystals, it also helps prevent devitrification and to maintain copper oxide in its reduced state by favouring a high Cu_2O/CuO ratio, thereby preventing the formation of a green coloured glass (Freestone, 1987; Brill and Cahill 1988, 19; Ahmed and Ashour 1981, Freestone *et al.* 2003). The visual impact is of a more intense red colour due to the growth of the cuprite crystals, and an increase in the refractive index and optical dispersion of the glass, so 'improving the gem-like qualities' (Freestone *et al.* 2003). Lead also lowers the melting point of glass, making it easier to work at lower temperatures, and helps to reduce stresses within the glass which could occur on cooling, especially when inlaid into metalwork (Henderson and Warren 1981).

[1] RB = Romano-British; LIA = Late Iron Age; MIA = Middle Iron Age; GLIA = Geometric Late Iron Age; SWR = sealing wax red; RB SWR = Romano-British sealing wax red; R SWR = Roman sealing wax red.

* Indicates that additional elements (with atomic number greater than manganese) have been removed, and the total normalised to 100% to provide a base glass composition.

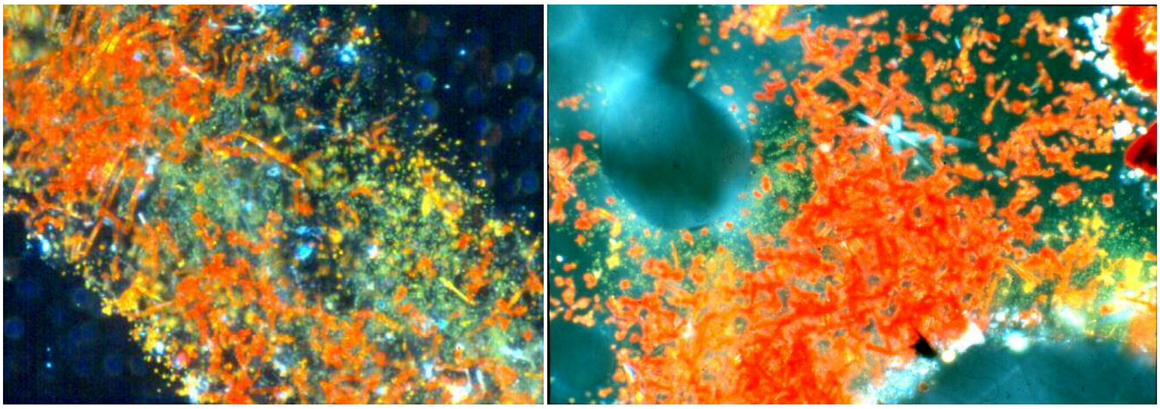


Figure 5. 2: Red sealing wax glass from a strap union (Alltwen) degraded by overheating or burning. Dendrites break up, become orange and red then dissipate as small green crystals. (Microphotographs: reflected polarised light and transmitted polarised light).

It is very likely that red glass objects were made by heat softening the glass and shaping it, or inlaying into metal voids or recesses. The outer surface when exposed to heat and air would darken, and this would need to be abraded away to reveal the bright red colour again. It is probably for this reason that so few red glass beads were made; they could not be fire-polished in the usual way without losing colour.

Figure 5. 3: Red glass ingot from Fish street, London (© Trustees of the British Museum). Small heated rod of red glass with darkened outer surface; the fractured surface still maintaining the bright red colour and a rod distorted by heating and softening (Culduthel, north east Scotland).

The production of red glass, irrespective of the quantity of copper and in some cases lead, required an internal reducing agent to maintain copper oxide within the glass in its lower oxidation state (cuprite). The two principle reductants that were used for this were either iron or antimony. Although iron often occurs as a trace element in silicon minerals, for the higher levels seen in some of these glasses, either particular sands were being sought or iron was being added deliberately. For both iron and antimony there does seem to be a chronological as well as a geographical correlation in the use of either of these reducing agents (figure 5.4; 5.5). However, the addition of iron would also have the effect of dulling the brightness of the glass by causing a natural blue or green tint, whereas the addition of antimony, which is present to some degree in most of the near Eastern and Egyptian glasses, but especially the former, would have aided both the reduction of the copper oxide, and the decolouration of the glass.

Iron was relatively abundant and easy to source in comparison to antimony, but antimony, like lead had many properties which enhanced the quality of the glass. Brill and Cahill wondered whether the near ubiquitous addition of antimony to early Egyptian red opaques was as a customary additive to luxury glass, serving both as a fining agent and a decolourant, while providing the crucial extra function of maintaining reducing conditions, and thereby with its multiple functions producing a brighter red glass (Brill and Cahill 1988, 19). The levels of antimony used in some of the very early glasses could be over four percent, but for red glasses in general, up to two percent would help the reduction of copper oxides in the melt and probably promote nucleation of cuprite or copper (figure 5.4; 5.5). Within glass in general it was the principal decolourant used in weakly coloured glasses up to the second century BC (Freestone *et al.* 2003, 146).

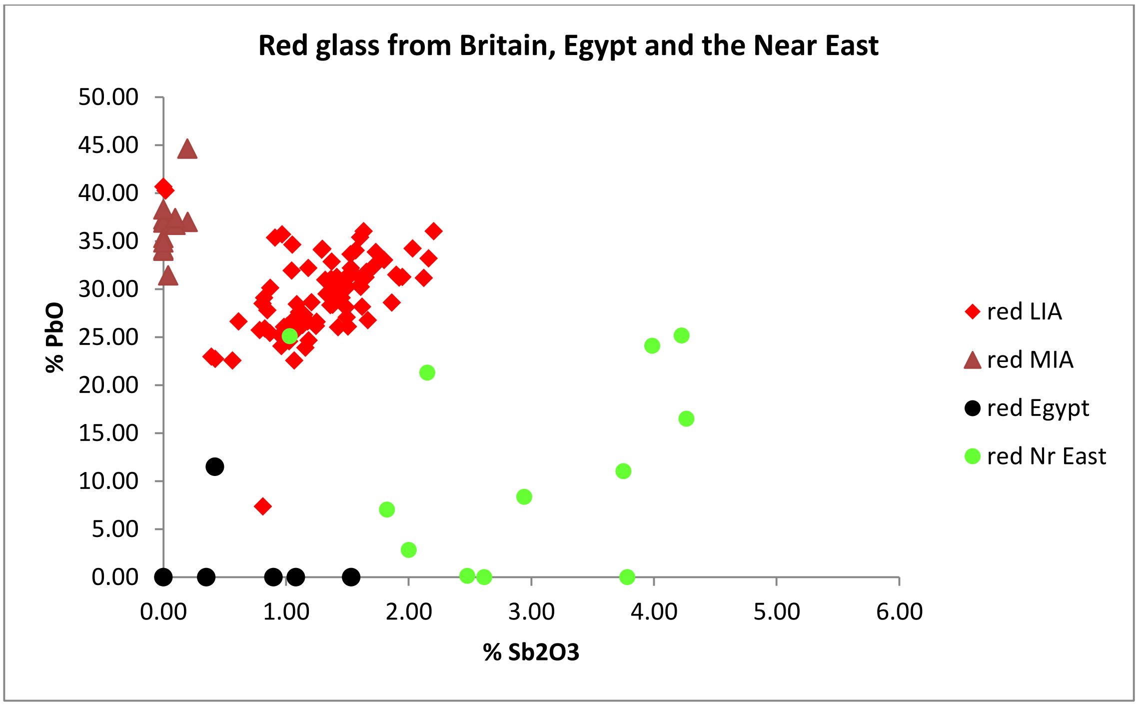


Figure 5. 4: shows some chronological as well as geographical pattern to the addition of lead and greater quantities of antimony; mostly occurring in the Near East rather than Egypt. (For sources: see appendix 3).

Antimony was also important as one of the principle elements used in both opaque yellow and white glass; and to lighten and opacify blue glass; all colours also used in the Iron Age for the manufacture of coloured and decorated beads. This makes its acquisition and technical use important for understanding many early coloured glasses (Shortland 2002). There were known antimony mines in the Caucasus, believed to have been exploited from the 17th century BC, which could account for the early use of antimony in glass; recently Degryse (in press) has argued for a principle source of antimony ores from Italy. There are also some sources within Britain, but no evidence that these were used (Henderson 1991, 69).

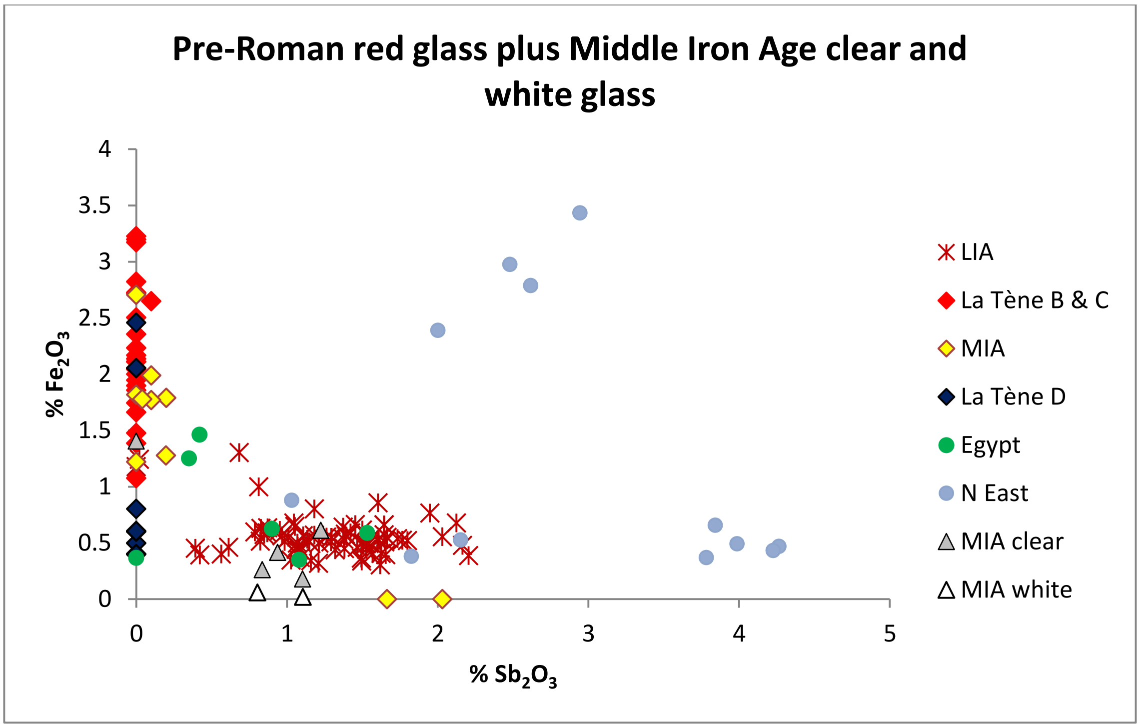


Figure 5. 5: Scatter diagram showing the deliberate addition of iron and antimony to control the colour and redox reaction of copper oxides, and colour and clarity in clear and white glass. (For sources: see appendix 3).

Once sand with sufficient lime to stabilise the glass was discovered, especially the Levantine sand which contained relatively little iron, and a steady supply of the mineral flux was available, the quantities and ease with which these materials could be obtained made it more straight forward to produce glass of a consistent quality in larger quantities. It would thereby have become a less exceptional product, although the pyrotechnological elements of glass-making would still require specific knowledge and skills. Glass forming was still laborious; the majority of artefacts produced continued to be core-formed vessels, moulded and cut vessels and many small items such as beads in a variety of colours. Artefact types such as cut vessels must have been prestigious and relatively rare items. Transparent glass became favoured in Hellenistic Greece, now that reasonable quantities could be produced, and the skill and time taken for production of the artefacts themselves, rather than the manufacture of the primary product, must still have made these valuable high status objects.

The production of opaque red glass was still relatively difficult to produce due to the specific conditions and materials needed, and it seems to have been made in smaller amounts. it could not be cast as easily as blue or clear glass, as the cuprite would oxidise to produce a dull green glass, theoretically it could be slumped into a mould and polished and cut down, but it would be difficult to manipulate this quantity of red glass whilst maintaining a consistent colour and opacity (Cable and Smedley 1987; Brill and Cahill 1988, 23), although red glass vessels were produced in the Hellenistic period (Brill and Cahill 1988; Bocshetti 2011). Small ingots of glass were probably produced, from which pieces were broken off and predominantly used to make small objects or used as inlays. Red glass probably maintained greater intrinsic value than other glasses as there are no naturally occurring red gems of that colour (Brill and Cahill 1988).

Iron Age opaque red glass in northern and western Europe

Opaque red glass originated in the Near East and Egypt, but in the second half of the first millennium BC it appears within La Tène Europe. It can be seen from the map (figure 5.6) that the trade and movement of this glass is not related to established trade routes in the Mediterranean or via Carthaginian or classical routes (the helmets from North Italy were in the region of the Boii). This is in contrast to coral, another prized material often used to decorate similar La Tène style objects, which was believed to have come from Mediterranean areas such as the Gulf of Naples (Kruta 2005, 72).

It appears from artefactual evidence that the use of sealing wax red glass in the second half of the first century BC developed in continental and temperate Iron Age Europe as a distinct tradition from the Hellenic, Hellenistic and Egyptian glasses, and with no influence from the Iberian Peninsula. The original colourless glass batches used for the La Tène glass were probably produced in the Near East; the soda lime silica composition suggests the use of mineral soda for the alkali. The process of colouring the glass could have taken place in a number of different workshops; perhaps traded to inland continental sites via Hellenistic routes by 'Celtic' mercenaries or tradesmen through Eastern Europe. The variable composition of sealing wax glass from both Early and Middle La Tène Europe, and Middle Iron Age Britain, might suggest less firmly established or frequently used workshops for colouring glass (figure 5.1; 5.7). Other colours of glass seen in this period also show a relative lack of consistency in base composition and added colourants. As Brill and Cahill point out 'time and again we have seen groups of early glasses from a single factory which had consistent compositions in its base glasses but widely varying composition in its colorants and opacifiers. This is due at least in part, to the frequent remelting and mixing involved in the production of red, yellow, and white opaques and their variants' (Brill and Cahill 1988, 22)

The Celts were known for their supply of mercenaries to the Near East in the fourth to third centuries BC, and a number settled in Galatia (in modern Turkey) in the early third century BC (Kruta 2005). The use of Celtic mercenaries was particularly popular in the Hellenistic period following the death of Alexander, and they fought and travelled over much of the Mediterranean, and must have influenced the movement and trade of both goods and ideas. One likely scenario derived from the sites where the red glass has been found, is that movement of this material, whether as clear ingots coloured on route, or as coloured blocks, followed the route of the Danube from the Black Sea, and then the Rhine and into northwest Europe to France and England (figure 5.6). All the areas within continental Europe where red sealing wax glass occurs were in regions of 'Celtic' expansion (Cunliffe 1991). This suggests the red glass was a particular cultural signifier in La Tène Europe, and one which probably carried specific connotations, which continued in some way into the Late Insular art of the first century AD.

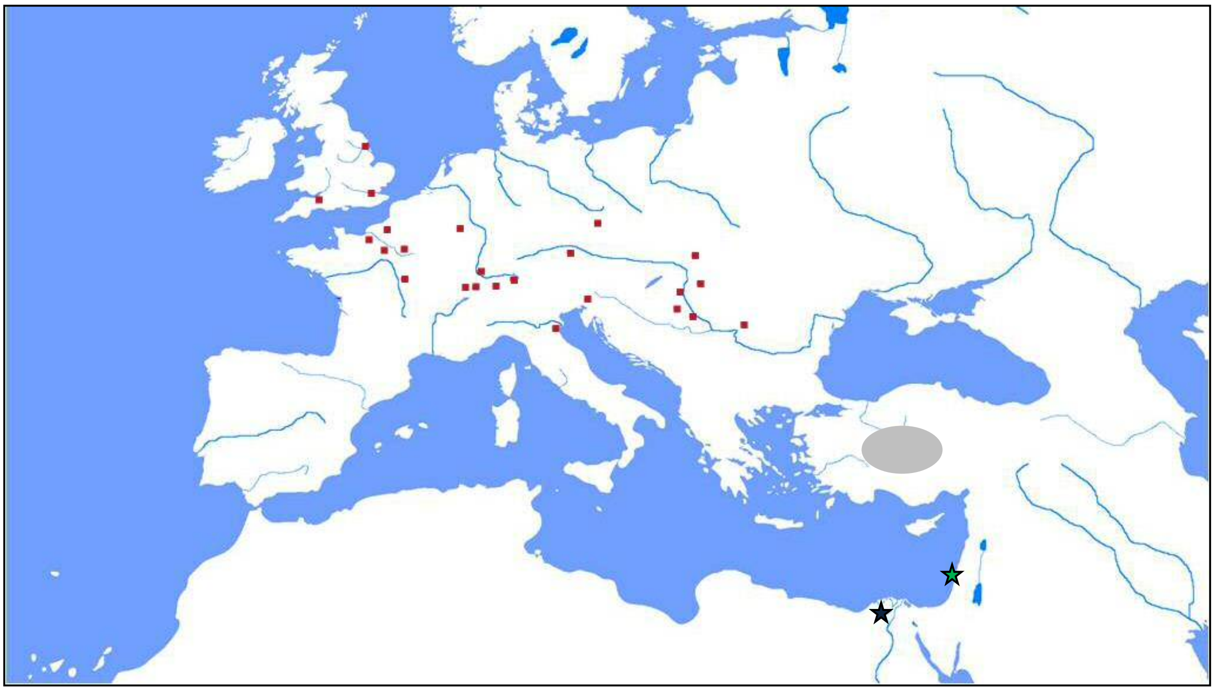


Figure 5. 6: Map showing provenance of continental La Tène B-D and British Middle Iron Age objects containing 'sealing wax' red glass (c.5th to 1st century BC). Red dots = Middle Iron Age and La Tène objects containing 'sealing wax' red glass; black star = source of natron; green star = source of sand. Grey: approximate area of 'Celtic' settlement of Galatia (Andreose et al. 1991; Brun and Pernot 1992; Kruta 2005).

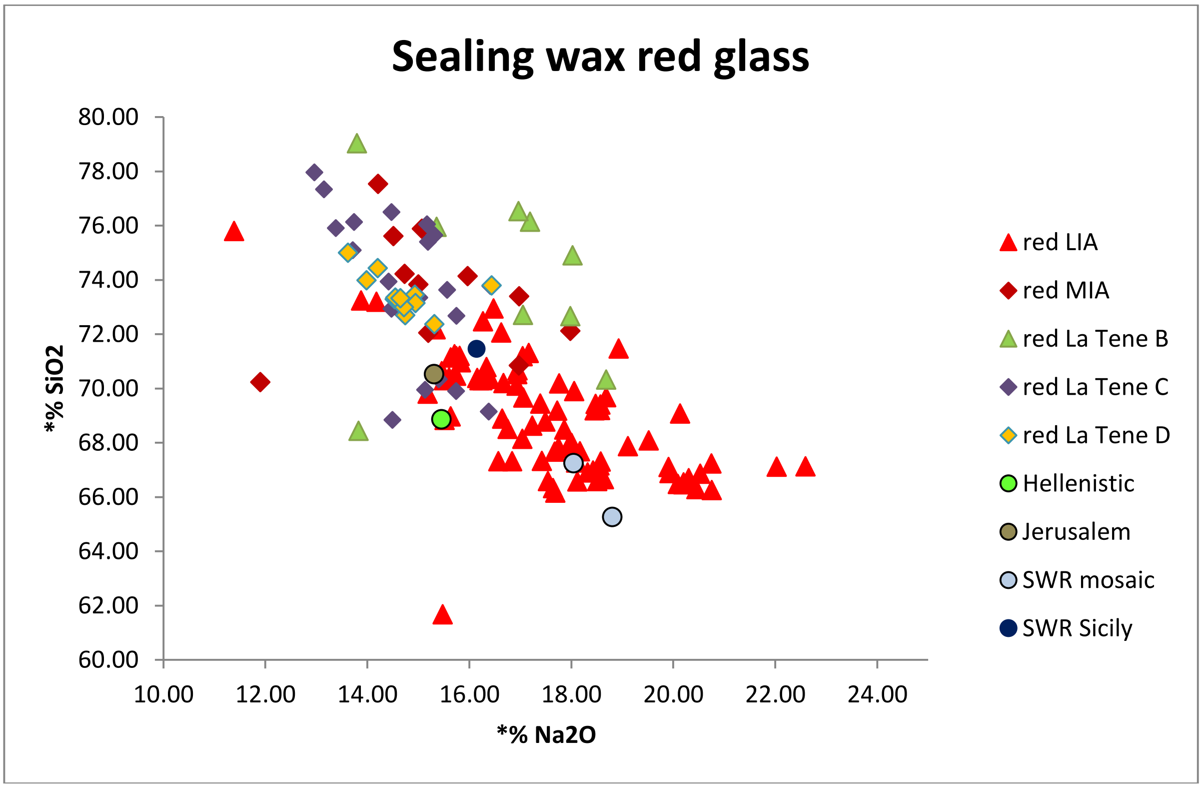


Figure 5. 7: Scatter diagram of soda and silica showing compositional differences between La Tène and British Middle Iron Age, and Late Iron Age sealing wax red glass. (For sources: see appendix 3).

Brun (1991) and Brun and Pernot (1992) analysed several of these glasses thought to date from the fourth to the first century BC, from France, northern Italy, Switzerland and Hungary (Brun and Pernot 1992, 240-1). Their results showed a mineral soda-lime-silica glass with high lead and copper oxide, and higher than usual iron oxide, probably added as a reductant. A few objects, mostly La Tène C belts, contained some antimony (between 400ppm and 0.2 percent), but specific quantities are not given. There is little distinction between dates and location for objects from La Tène B-C except that western European objects contained slightly less copper (Brun and Pernot 1992, 249). The main difference observed was in the La Tène D samples from Mont-Beuvray, an oppidum with close connections to the Roman world. These glass objects are predominantly dribbles, lumps and chips suggesting glass-working at the site, and they contained significant manganese (c.0.5%), indicating a different source for the glass, possibly originally a clear Roman glass, as the addition of manganese as a decolourant is thought to be a Roman technological trait dating from the second century BC (Henderson 2000) (figure 5.9).

Figure 5. 8: Amfreville helmet; La Tene B-C, (photograph: http://en.wikipedia.org/wiki/Gauls); hilt of Kirkburn sword; Middle Iron Age (photograph: ©Trustees of the British Museum);
decoration on Battersea shield; Middle Iron Age, (photograph: ©Trustees of the British Museum)

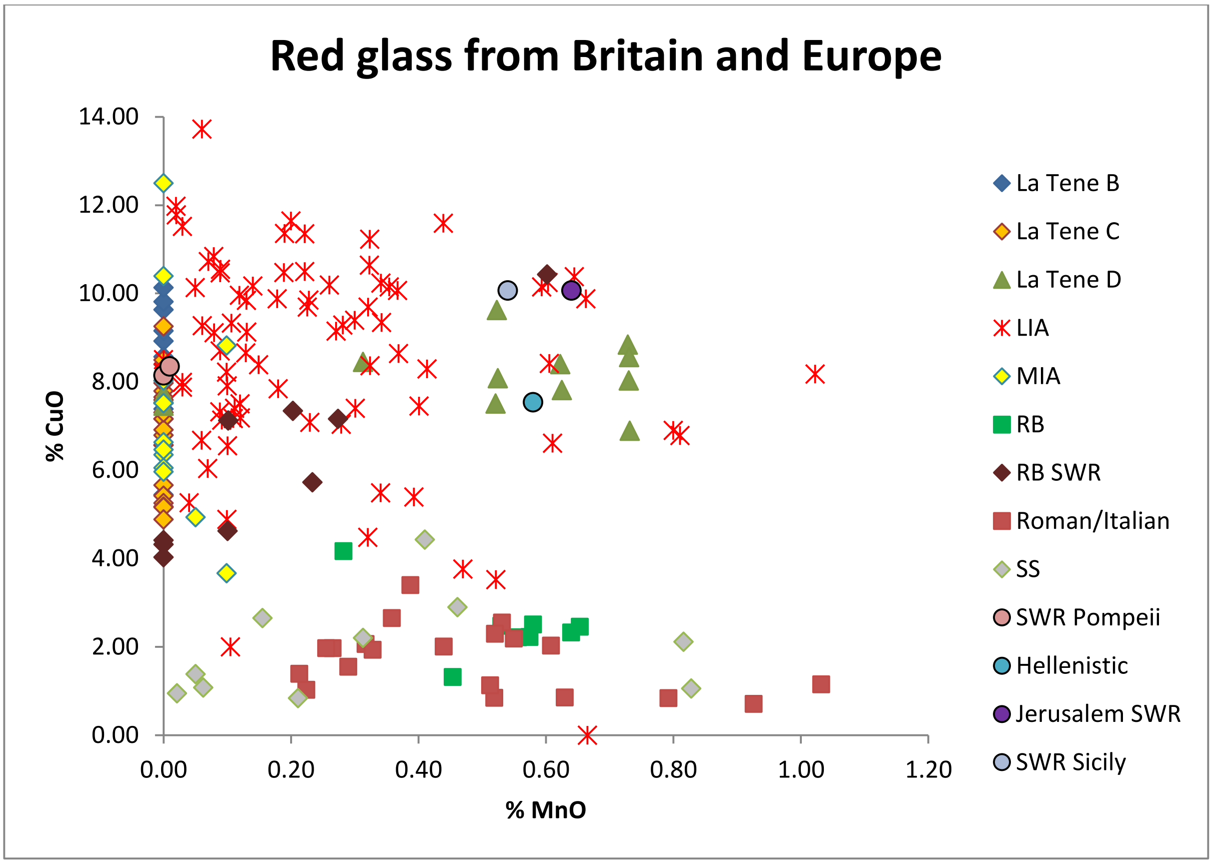


Figure 5. 9: Scatter diagram of Iron Age and Roman glass from Britain and the continent showing higher manganese levels for La Tène D glass from Mont-Beuvray and for Italian and Romano-British 'dull' red tesserae. (For sources: see appendix 3).

It can be seen that Late Iron Age red glass from Britain differs from the majority of opaque reds from continental La Tène and British Middle Iron Age reds. There is a clear pattern showing the mutual exclusion of iron and antimony as reducing agents (figure 5.5).

A further significant technological advance takes place at the end of the production of continental La Tène and Middle Iron Age glass in the first century BC, and the beginning of the production of British Late Iron Age glass in the first century AD. During this period glass blowing became established (first accomplished in the first century BC) (Boschetti *et al.* 2009, 139) and the mass production of glass exported for the manufacture of objects such as vessels was in demand. It is likely large quantities were produced in massive furnaces similar to the slightly later examples from Bet She'arim (Freestone and Gorin-Rosen 1999). The production of large clear glass batches used either antimony or manganese as a 'decolourant' within the melt. Clear glass was preferred for the production of vessels rather than the naturally occurring green-blue tinted glass. As more Roman glass started to be produced for export throughout the Empire in the first century AD; it appears different sources of the primary ingredients were used. This general trend can be seen by plotting alumina and lime levels of the base glass to give an overall impression of different provenances for the silica and lime. The vessel glass from Britain shows a different composition to glass sourced from the Eastern Mediterranean (figure 5.10).

Despite the availability of quantities of colourless glass in Britain, the composition of the base glass used for sealing wax red glass still retained an Eastern Mediterranean signature (figure 5.10). This implies it was not acquired through the same trading system to Britain as the clear glass, but that specialist coloured glass was produced elsewhere in Europe.

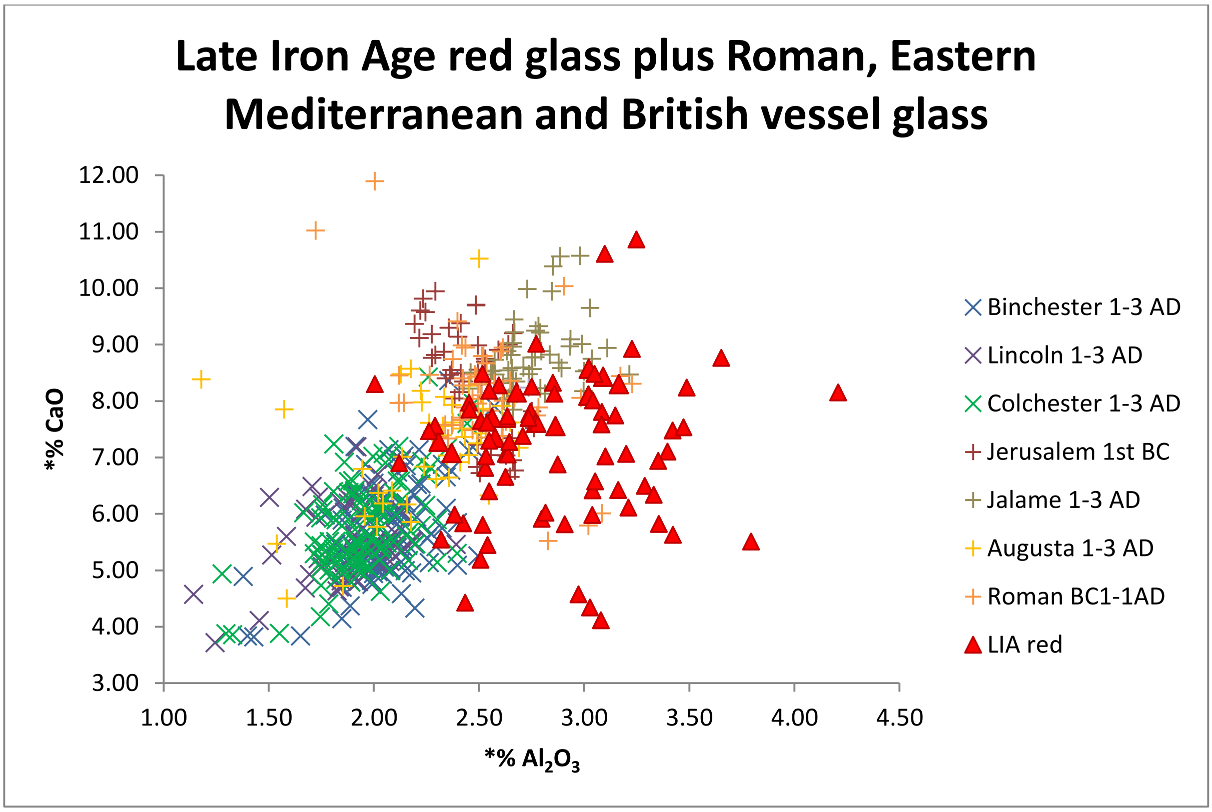


Figure 5. 10: Roman, Eastern Mediterranean and British vessel glass, plus Late Iron Age sealing wax red glass; the red largely overlaps with Mediterranean rather than British glass. (For sources: see appendix 3).

The Late Iron Age sealing wax red glass from Britain was unlike other Iron Age sealing wax red glass; antimony instead of iron seemed to act as the reducing agent within the melt to aid the formation of cuprite within the glass. Antimony had been used in opaque red glass in the Near East (figure 5.4), and then abandoned in the continental European Iron Age. Both manganese and antimony were used to decolour Eastern Mediterranean and western European vessel glass in the first century AD, but antimony was usually added in lower quantities than the one to two percent normally present in the Late Iron Age red glass (figure 5.4; 5.5).

There was not only a change in the red glass composition, but also a change in its application and the decorative style of the metal objects. Three-dimensional forms were flattened, and voids and shapes were made larger, with the interplay of shapes depicted through the contrasting colours of bronze metal and red glass, in a manner similarly delineated through the use of cross-hatching on larger and flatter surfaces. In the first century AD large shapes were usually cast into the design, or sometimes later excised out of the metal to take the inlaid red glass (e.g. figure 5.12).

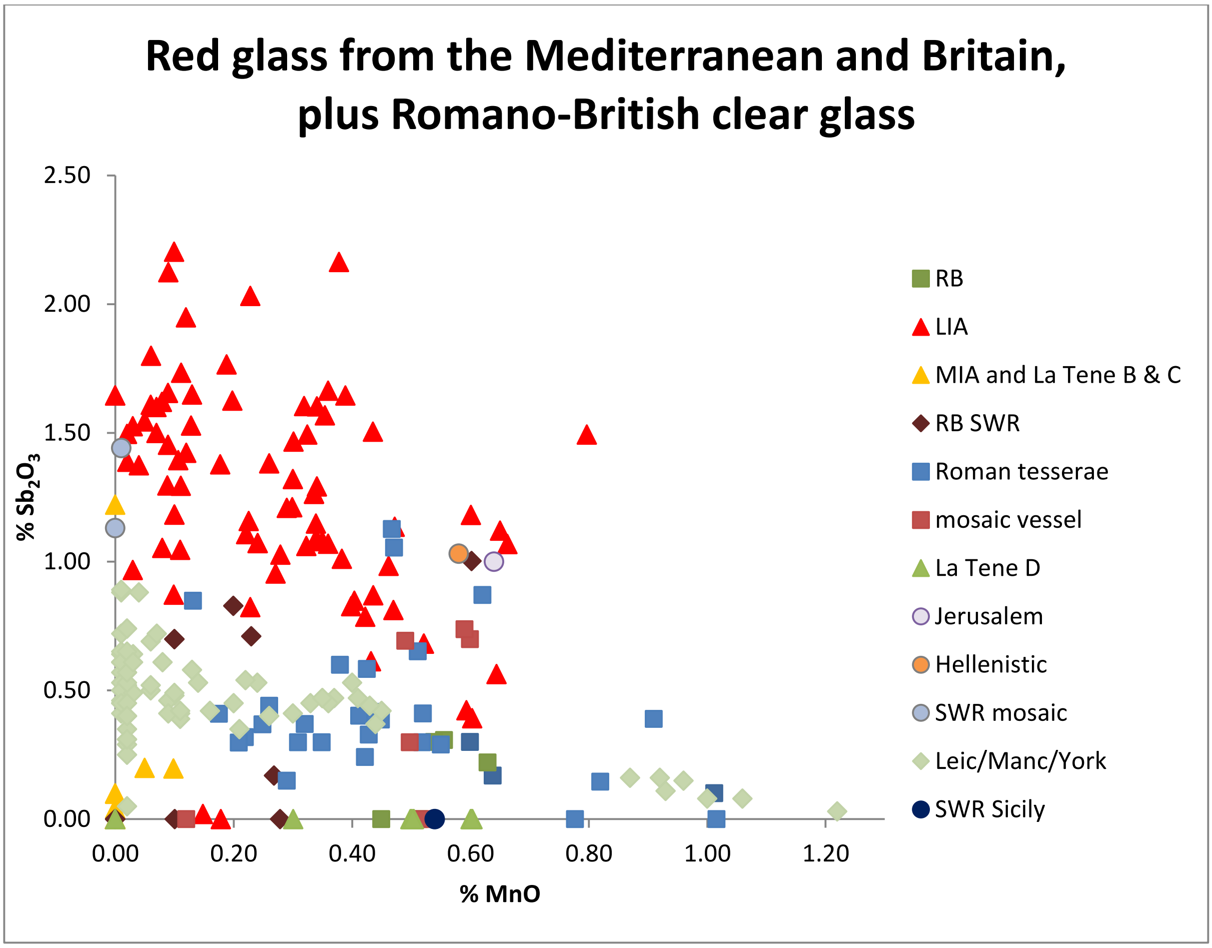


Figure 5. 11: Scatter diagram showing the principle decolourants used in the Late Iron Age and Roman periods; the majority of La Tène B and C and British Middle Iron Age glass use neither. Roman red glass appears to use both, probably the result of recycling, though there is some correlation with decreasing antimony oxide levels and increasing Manganese oxide levels, seen here for the British vessel glass from Leicester, Mancetter and York, and for the Romano-British red glass. (For sources: see appendix 3).

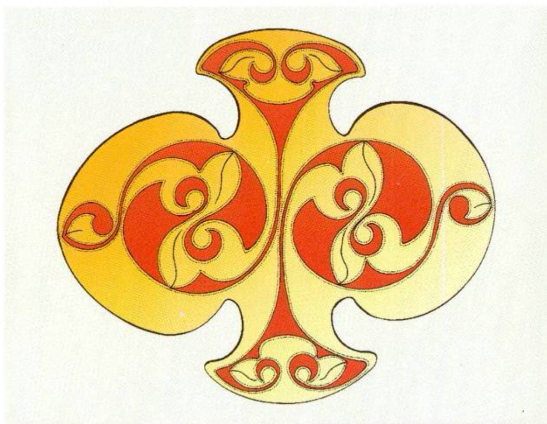


Figure 5. 12: The strap union from Alltwen; reconstruction drawing by Tony Daly. Large recessed areas have been cast into the object to take inlaid red glass (©National Museum of Wales) .

A further change which took place was the introduction of polychromy; this introduced areas of lead rich yellow glass, which could be inlayed in a similar way to red opaque glass (for example with the Maendy strap union, Figure 5.13); occasionally some pieces had small areas of blue glass applied as dots, or roughly cut and inlaid fragments into the metal, as with the terret from Middlebie (Figure 9. 9; 9.38) and the brooch from Culduthel (Figure 5.13). Yellow seemed to become more acceptable as a colour on artefact types in the Late Iron Age, where previously only red glass had been used.

Figure 5. 13: Strap union from Maendy, South Wales, showing large areas of inlaid red and yellow glass plus detail; fantail brooch from Culduthel near Inverness showing red, yellow and blue glass inlaid glass.

Colouring Late Iron Age 'sealing wax' red glass from Britain

There was a significant increase in the amount of red glass used in the Late Iron Age compared to the whole of the La Tène and Middle Iron Age periods. This was not only in the number of objects decorated, but also the quantity used, especially for pieces such as the quadrilobed strap unions (e.g. figure 5.12). This use was occurring at a time when sealing wax red was rarely used on the continent; Roman red glass with low lead and low copper contents largely replaced its use (Brun and Pernot 1992).

The use of manganese and antimony are interesting; in some ways they perform a similar function; manganese rich glass was used for La Tène D glass from Mont Beuvray (figure 5.9; 5.11) which suggests a Roman decoloured glass (Jackson 2005), but in Britain there was the consistent use of antimony, plus a number of examples which incorporated both manganese and antimony (figure 5.11), possibly implying the recycling of glass. Antimony had been used in the Middle Iron Age to colour and opacify clear, white and yellow glass, but not red (figure 5.5), but its use within sealing wax red in the Late Iron Age suggests a change in technology and trading patterns, possibly with a Roman Mediterranean route coming into use, rather than a trans European mainland one.

This begs the question of where the red glass was coloured. One possibility is that it was coloured in the Mediterranean, either where the original glass was made, probably in the Levant, or in a number of secondary centres. Coloured glass had remained popular in the eastern and southern Mediterranean throughout the second half of the first millennium BC, especially in Greece and Egypt, but was slow in being adopted in the Roman world. The Gulf of Naples appears to have had close cultural links with Egypt and the Near East, and these two regions were largely responsible for the development of glass technology, for example the invention of glass blowing in Syria (Boschetti *et al*. 2009, 139).

At the beginning of the first century AD a limited amount of coloured glasses were used in Roman mosaics and these included some pieces of sealing wax red. Towards the middle of that century glass tesserae were used more frequently, with the majority found at Pompeii (Boschetti *et al.* 2009, 143). In Pompeii, c. AD 30-40, in 'the fountain of the Casa del Granduca di Toscana, [which] was characterized by an abundant use of glass, the red tesserae were cut from vessels' (Boschetti *et al.* 2009, 141). These vessels originally dated from the third century BC to the middle of the first century AD (Boschetti 2011), and probably originated in the near East and were popular within the Hellenistic world. From the late forties to the early sixties AD, the use of glass tesserae was well established, and re-used broken red vessels were employed less; similarly 'Egyptian blue and sealing wax red glass were abandoned by mosaicists' (Boschetti 2011, 89). From this time on, it seems purpose made glass cakes (using dull red glass amongst the colours) were purposely produced for mosaics in Italy.

There have been several examples of the use of sealing wax red glass used in mosaics cited in the literature (Daniele *et al.* 1999; Boschetti *et al*. 2007; 2011), but very little published analysis; the published detailed composition of five pieces of Mediterranean sealing wax red glass have been used to give an indication of composition, but without more data it is difficult to draw many conclusions. These include two fragments from Pompeii (Arletti *et al.* 2006; Boschetti *et al.* 2007) one tessera from Segesta in Sicily (Daniele *et al* 1999); one first century BC red glass fragment from Jerusalem (Freestone pers. comm.) and a fragment from a third to second century Hellenistic bowl (Brill and Cahill 1988). Their analyses are incorporated within some of the scatter diagrams in this chapter.

The composition of the red vessel glass is similar to the Late Iron Age sealing wax red in many respects, and some vessels were probably exported to southern Italy, where broken fragments were later used in a relatively limited way and for a relatively short time as tesserae within in nymphaea. This makes the export of sealing wax red glass from Italy to north west Europe less likely than from the original source in the eastern Mediterranean; but there is little evidence of cultural material or novel technologies coming directly into Britain from there; the evidence for Roman style dull red glass entering Britain in the later first century AD is much stronger.

The use of relatively large quantities of sealing wax red glass in the first century AD, incorporating antimony was largely a British phenomenon (except for the vessel glass in Italian mosaics). Clear glass which could be coloured was readily available, but antimony would have been harder to obtain in the quantities seen. One possibility is that yellow glass was imported as ingots in the Late Iron Age (there is evidence for the manufacture of yellow beads at Culduthel (Davis and Freestone forthcoming). Analysis discussed below explores the possibility that this yellow glass could have been used as the principle source for the sealing wax glass, made red by the addition of copper and lead, which were readily available in Britain.

There is also a change in the composition of yellow glass in the Late Iron Age in Britain. This is seen by the decrease in iron oxide, and the increase in manganese oxide (figure 5.14). Yellow glass was not as technically demanding to manufacture as red glass as long as the appropriate ingredients were accessible, so was possibly coloured at more centres; Roman yellow tesserae and mosaic vessels (Mass *et al* . 1998) have compositions similar to many of the Late Iron Age yellow glasses analysed from Britain (figure 5.14; 5.16).

Opaque yellow glasses were manufactured early in the history of glass making. The more usual colourant was lead antimonite, though lead stannate was also used as a yellow colourant and opacifier in limited quantities towards the end of the first millennium BC in Britain, France and the former Czechoslovakia, and continued to be used up to the second century AD in Scotland (Tite *et al.* 2008 67).

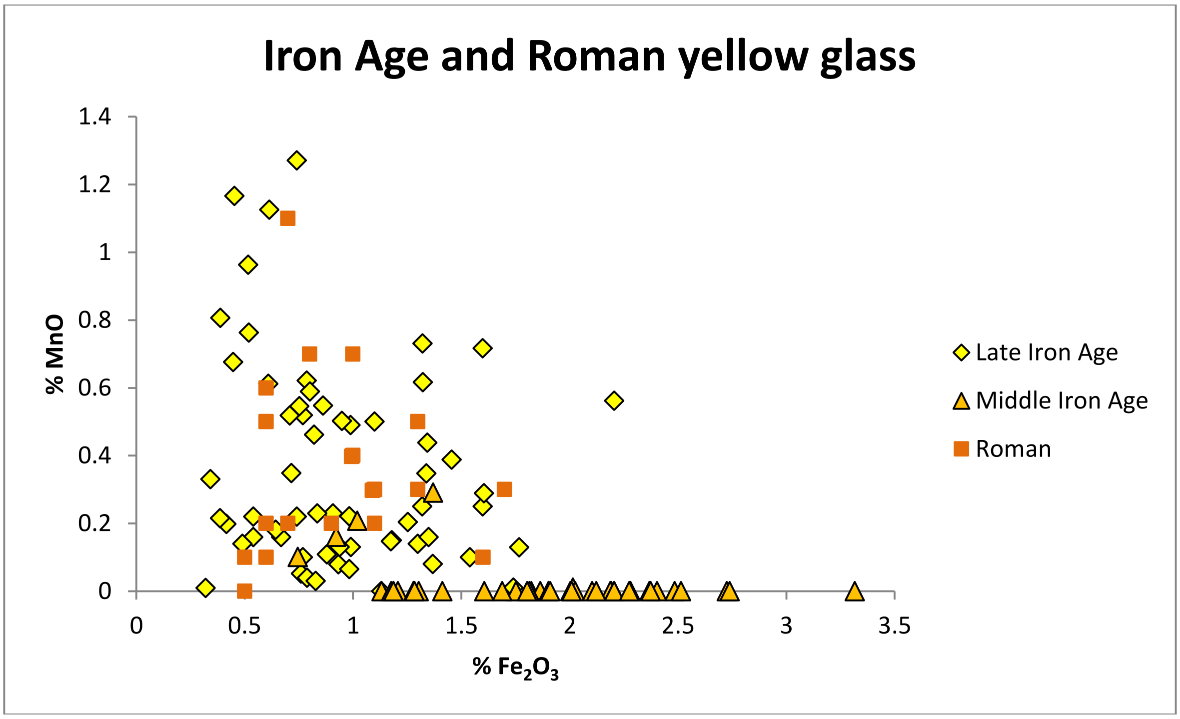


Figure 5. 14: Scatter diagram showing the iron oxide and manganese oxide levels in British Iron Age and Roman yellow glass. (For sources: see appendix 3).

Lead antimonate rarely occurs as a mineral in nature, and was probably manufactured as a pigment by the combination of lead and antimony ore minerals (Shortland 2002, 524). Brill refers to a known trade in lead antimonate, a material prepared by craftsmen other than glassmakers and 'a commodity traded over considerable distances' (Brill 1970, 119). This yellow pigment was added to the glass, but was very susceptible to degradation at high temperatures, which could cause it to dissolve in the glass, and lose its yellow colour. 'To prevent this, the pigment probably has to be folded into the glass at relatively low temperatures, when the glass is extremely viscous and plastic'. (Shortland 2002, 525). This fact could help account for the relatively large amount of lead in the glass, which would make it workable at lower temperatures, as well as explain the poor mixing and distribution of the lead antimonate crystals (figure 5.15). This technological aspect of producing yellow glass has been shown further by experimental glass-making and colouring using lead antimonate yellow ‘as lead and antimony will not combine to form yellow in a single stage melt: instead antimony combines with calcium to form opaque white’ (Taylor and Hill 2002 Newsletter 3).

The fact that lead antimonite will dissociate on heating means that if yellow glass was used as the base glass to form sealing wax red, there would not be remnant crystals, and the lead antimony and copper could work to form a reduced copper glass promoting the growth of cuprite crystals. There is relatively little Late Iron Age yellow glass: Tite *et al.* (2007, 82) believe that lead stannate was used because antimony coloured glass became scarce. It could equally be argued that the scarcity of Late Iron Age yellow glass was due to its use for the production of red glass, a more sought after commodity for the decoration of high status metalwork.

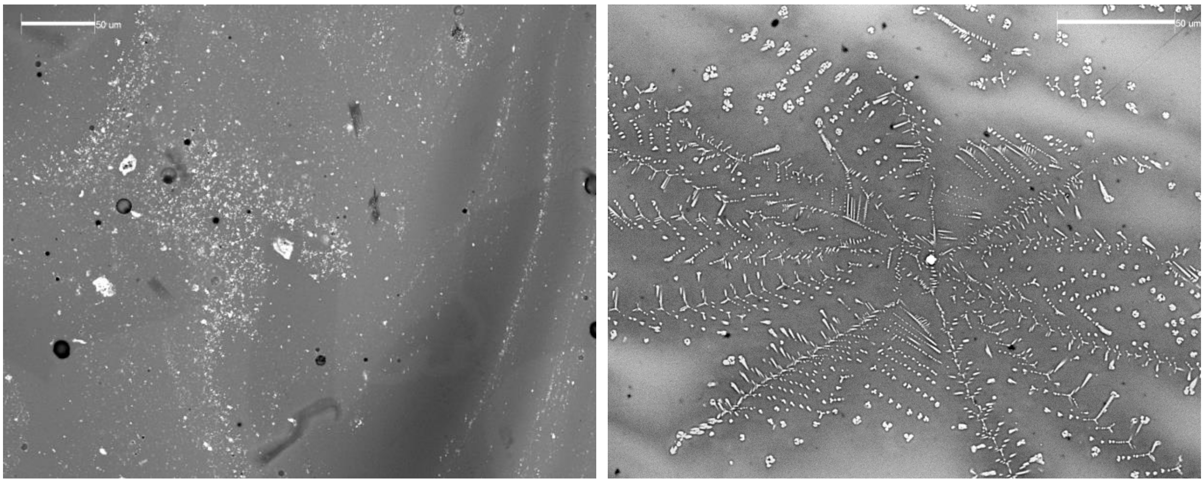


Figure 5. 15: SEM micrographs: Opaque yellow glass from an IA strap union from Maendy, coloured and opacified with lead antimonite, showing the uneven distribution of crystals and directional flow indicative of incomplete mixing at lower temperatures. Red sealing wax glass from a stud from Whitton showing branched cuprite dendrites in glass (Scale bar = 50µm).

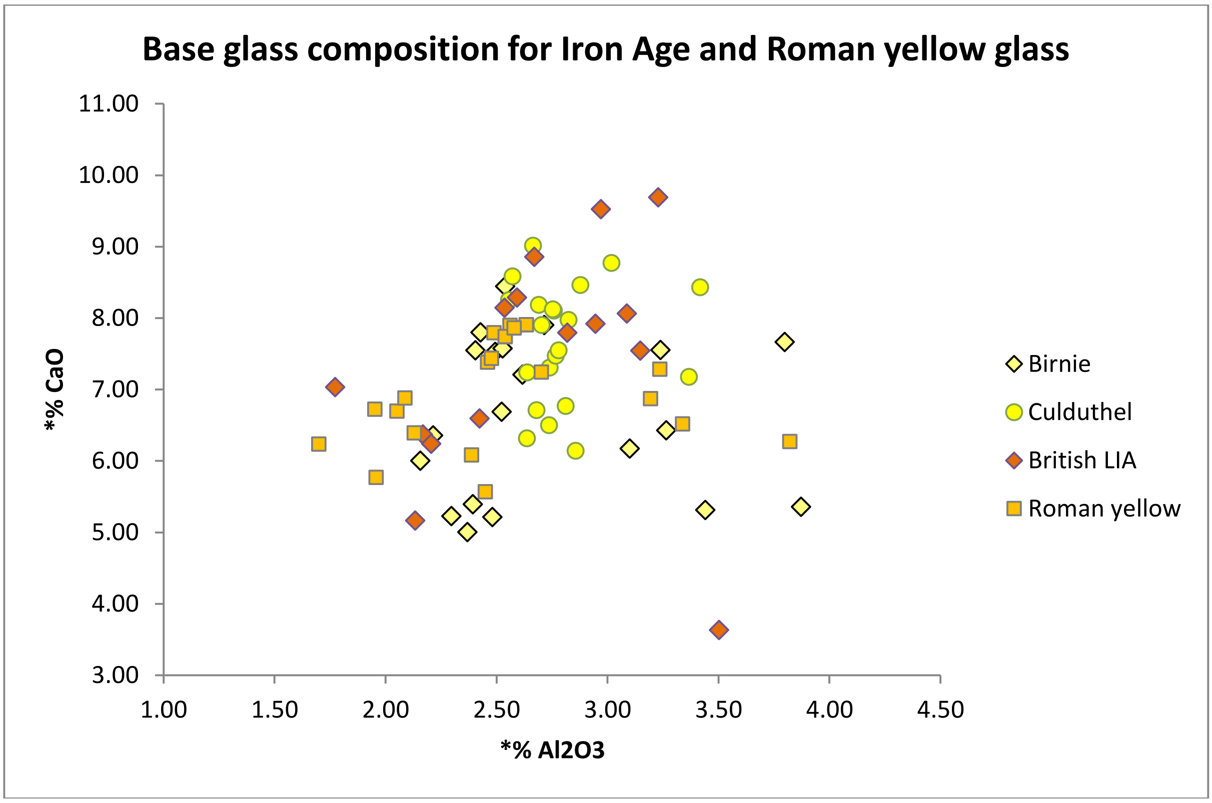


Figure 5. 16: Scatter diagram showing the base composition for Late Iron Age and Roman yellow glass. (For sources: see appendix 3).

The site of Culduthel, near Inverness has produced contemporaneous red and yellow glass (Davis and Freestone forthcoming); the two colours were worked together on some fragments. Both these colours had a similar base glass composition.

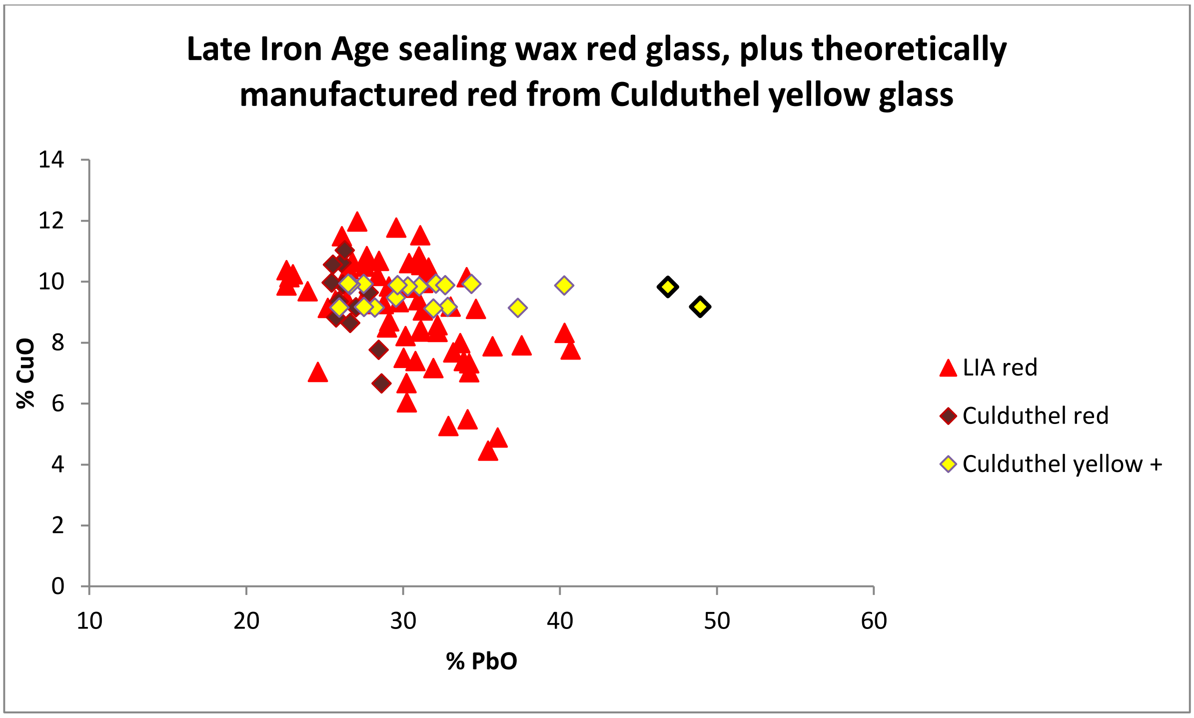


Figure 5. 17: Scatter diagram showing theoretical composition of yellow glass from Culduthel with added lead oxide (18%) and copper oxide (12%). The symbols outlined in black represent yellow glass coloured with lead stannate. (For sources: see appendix 3).

If a theoretical amount of lead oxide and copper oxide (in this study 18% and 12% respectively) were added to the analysed data for the yellow glass, and the new totals normalised to 100%, the new copper and lead oxide levels closely match those for the composition of Late Iron Age sealing wax red glass (figure 5.17).

After lead and copper values have been roughly matched, it is possible to see how other elements within this system appeared. Despite the relatively basic initial calculation, there are similarities for quite significant elements such as antimony and manganese between the sealing wax red glass and the theoretically red-coloured yellow glass (Yellow +) (figure 5.18; 5.19).

Another factor is the possibility that ingots of lead stannate yellow were also used to produce red glass. If this was the case, then the subsequent red glass would lack antimony but contain some tin. The circled area in figure 5.18 is where lead stannate yellow glass objects appear; amongst these are several examples of Romano-British sealing wax red glass, which tend to have a more variable overall composition than the Late Iron Age sealing wax red glass (figure 5.9; 5.11; 5.21). The red glasses included in the circle all contain some tin (between 0.5 and one percent). They consist of: irregular lumps from Castleford (Bayley 2005), a Romano-British enamelled brooch and bird pin from Birnie (Davis forthcoming), a Roman style ring with inlaid red and blue glass from Tintern in Wales (appendix 8), and an ingot from Fish street (Freestone *et al.* 2003). It has been argued that tin results from the addition of bronze or leaded bronze and the proportions and quantities present are roughly correct for this (Freestone *et al*. 2003). However, Freestone *et al*. (2003) feel the sporadic occurrence and quantity of tin in red glass means it was unlikely to be the result of deliberately added metal scale. The addition of lead and copper to lead stannate yellow to form red glass seems equally possible.

The production of lead stannate glass might have had certain similarities to making lead antimonite glass. Analytical work by Heck *et al.* (2003) on a Merovingian crucible fragment containing yellow glass, and tin opacified beads from the same area of Schleitheim in Switzerland, show that the concentration of the tin and lead within the crucible is far higher than in the manufactured beads. This work led to the conclusion that the yellow colourant was produced independently, and later added to clear soda-lime-silica glass during a separate part of the manufacturing process.

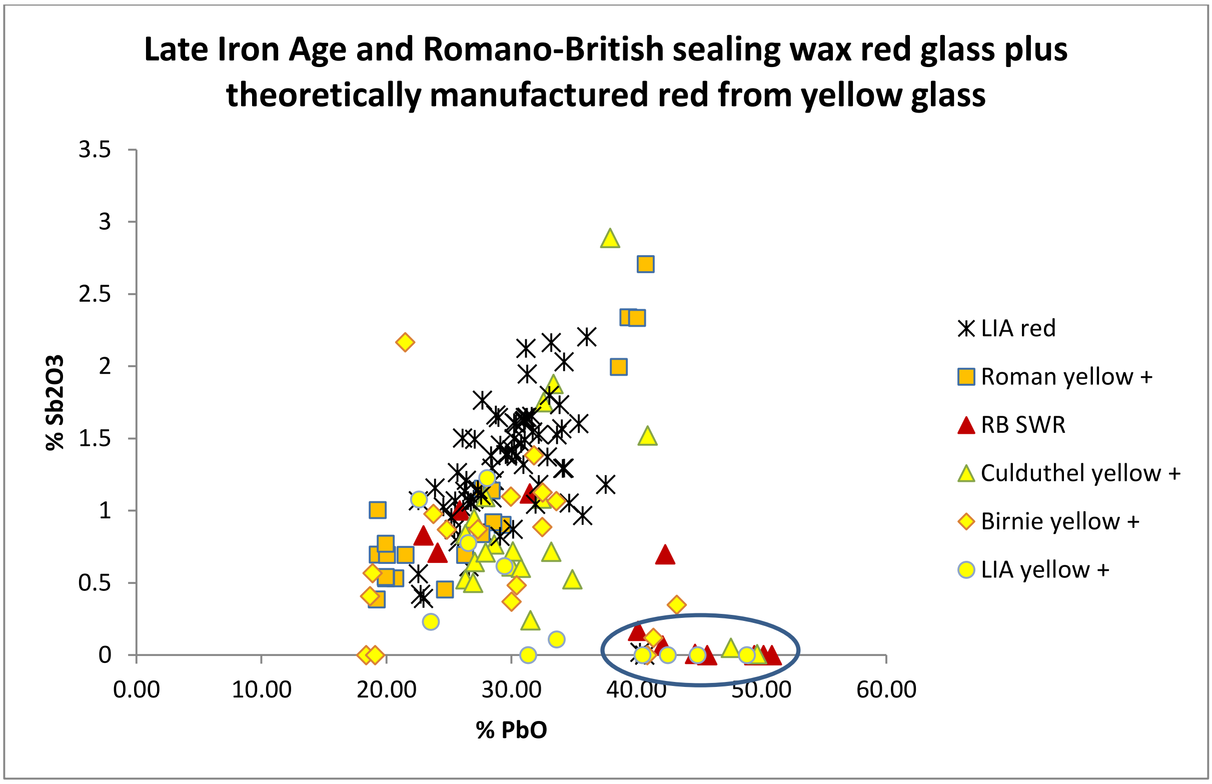


Figure 5. 18: Scatter diagram showing lead oxide and antimony oxide levels for Late Iron Age red glass and theoretically coloured yellow from Late Iron Age and Roman yellow glass. The area within the blue shape contains lead stannate glass and tin-rich Romano-British red glass. (For sources: see appendix 3).

If red glass was made from yellow glass, this hypothesis echoes Freestone *et al.*'s past argument for the use of litharge that 'the surprisingly sophisticated level of empirical understanding of the effects of various metallic oxides...is no longer required' (Freestone *et al.* 2003). This means that a large number of centres throughout Europe and the Mediterranean could have produced red glass relatively easily. However, this picture remains confusing: Roman opaque red mosaic vessel glass, analysed by Freestone and Stapleton (2015) contain tin, though conversely the opaque yellow mosaic glasses are coloured with lead antimonite; which would again suggest coloured ingots were traded from certain centres to a different set of specialist glass workers.

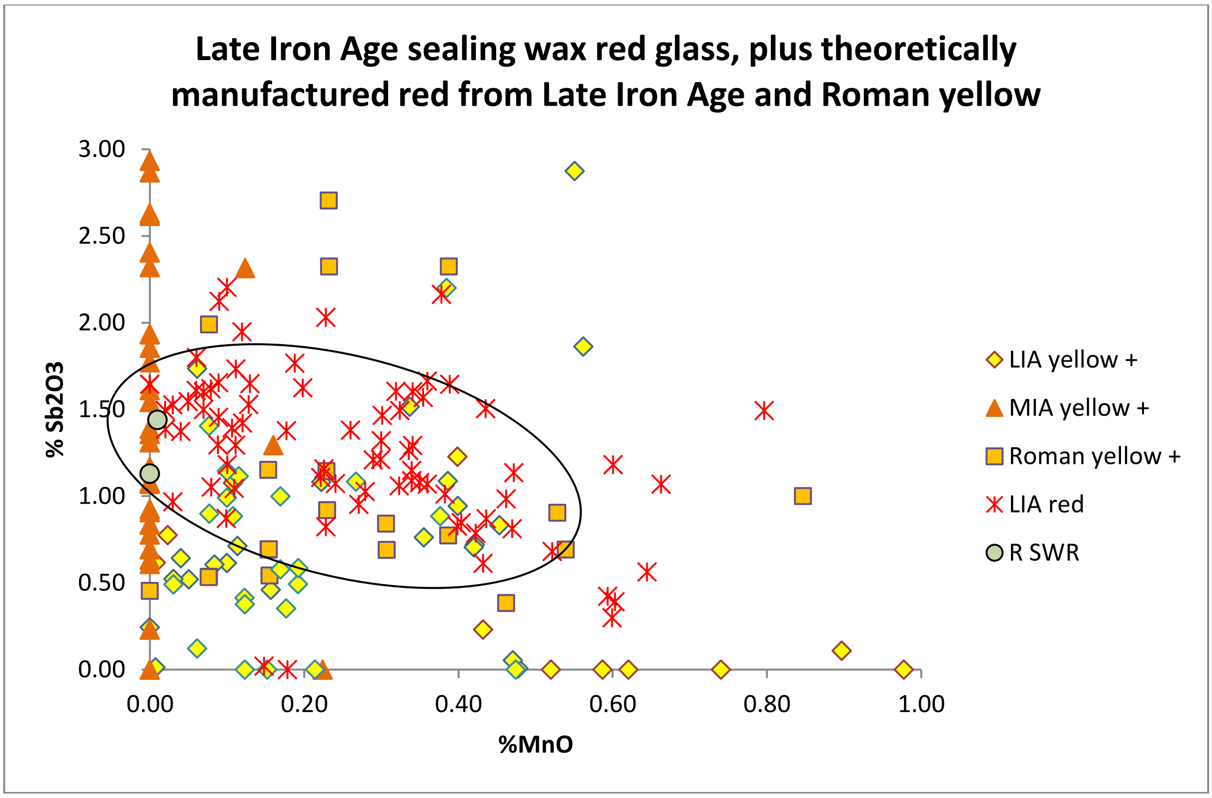


Figure 5. 19: Scatter diagram showing similarities for antimony and manganese oxide levels in theoretically coloured red and Late Iron Age sealing wax red glass, although with this calculation (addition of 18% lead oxide and 12% copper oxide) the antimony levels appear slightly low. (For sources: see appendix 3).

Roman and Romano-British red glass

There are a number of near contemporary red glass compositions within Roman Britain, which were produced at a similar time to the Late Iron Age sealing wax red glass, but their use continued for longer. Unlike the Iron Age glass, these show a far more varied base composition, with many small dispersed groups (figure 5.22). Some inconsistency of the Romano-British sealing wax red glass has already been mentioned, but a further type of glass containing low levels of lead and copper was regularly used in Britain from the first century AD onwards (figure 5.21). This glass was probably originally produced for tesserae in Italy (Bocshetti 2011), and was used throughout much of the Roman Empire. Within Britain it seems to have been used regularly for enamelling metalwork, especially brooches.

For the low-lead low-copper red glass, the copper was present as sub-micron particles (Barber *et al.* 2009) rather than as cuprite dendrites (figure 5.15). This made the glass a duller red in appearance to that of the sealing wax red glass, but it had many advantages. It was easier to produce large quantities that were not so likely to discolour during manufacture; it needed much less copper and lead; it could be cut, heated and worked without discolouring, and it could be ground and made into a paste for enamelling metal cells, which meant decorated metal objects were easier to produce.

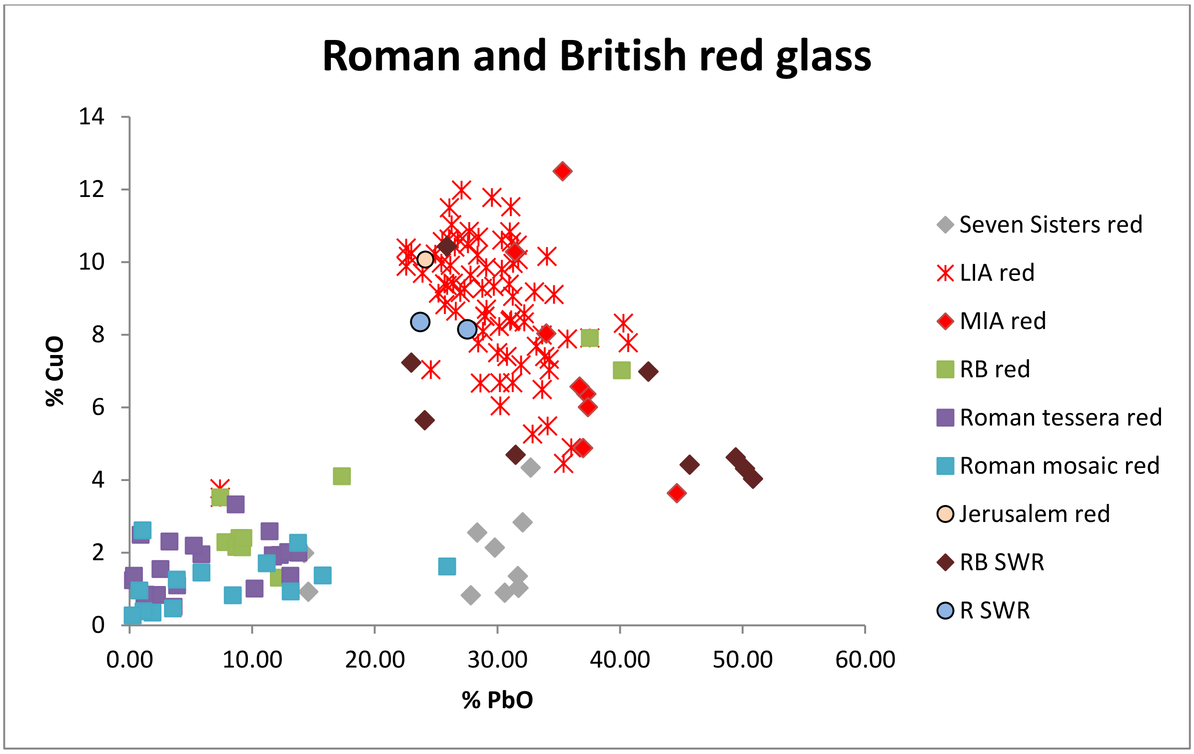


Figure 5. 20: Scatter diagram of Late Iron Age sealing wax red glass plus Roman and Romano British red glass. (For sources: see appendix 3).

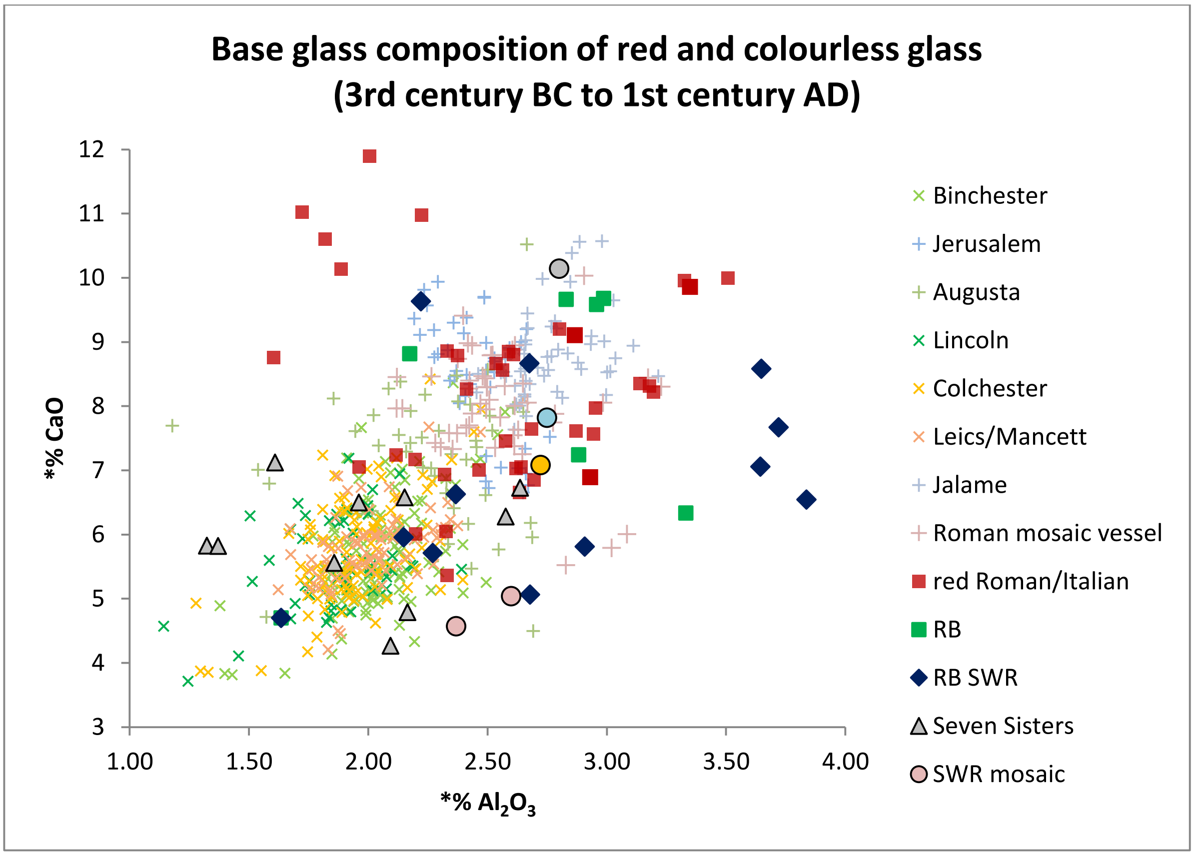


Figure 5. 21: Scatter diagram of base glass compositions of glass from the Near East, the Eastern Mediterranean with Roman red tessera glass and various glasses from Roman Britain. (For sources: see appendix 3).

Henderson lists three types of low-lead low-copper red glass (Henderson 1991), but it seems likely these duller red glasses had a large number of variables (Freestone *et al.* 2003), possibly produced by many different centres colouring glass in a number of slightly different ways. Figure 5.20 shows that there was also some variation in base glass compositions for these glasses. Other factors such as a high level of potassium in some glasses (figure 5.22), could be accounted for by adding fuel ash, which frequently contained finely divided charcoal, to help retain a reducing atmosphere when colouring or shaping the glass (Freestone and Stapleton 2015).

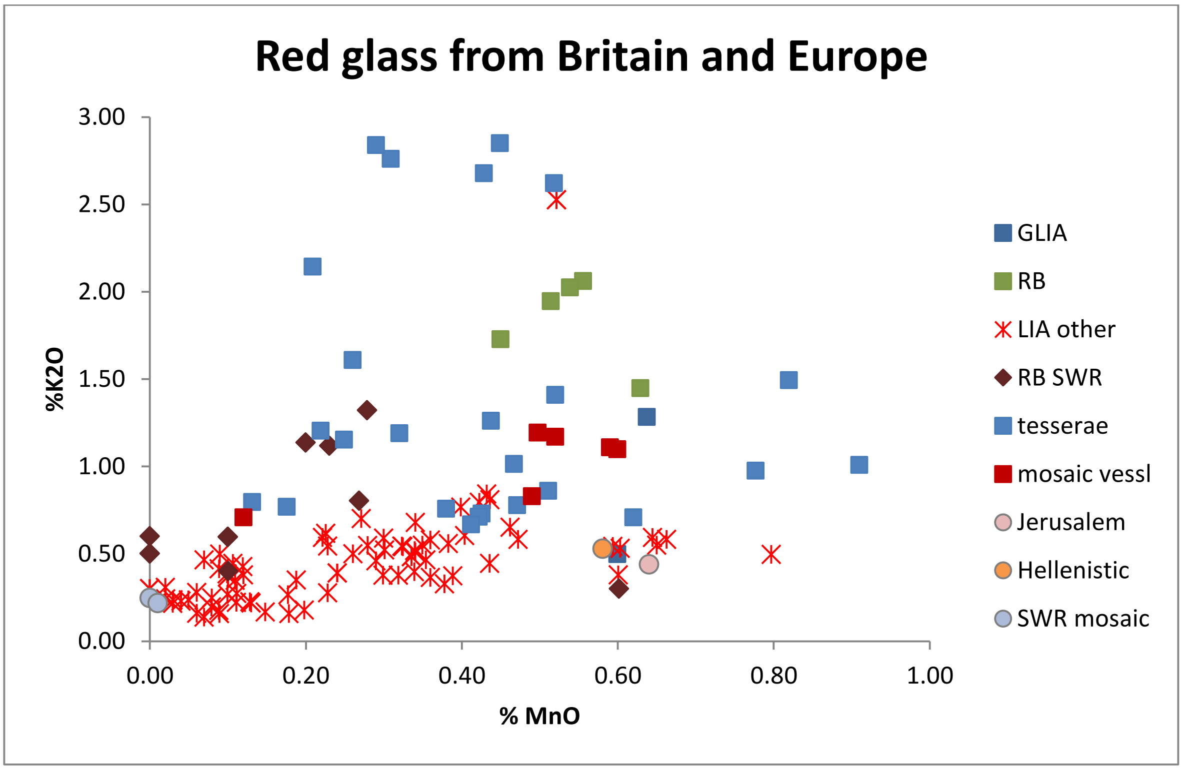


Figure 5. 22: Scatter diagram showing the majority of Roman red glass decolourised with manganese oxide (above 0.2%), and variable quantities of potash within Roman and Romano-British glass. (For sources: see appendix 3).

Boschetti argues that from the first century AD onwards, the increased amount of naturally coloured raw glass produced for glass blowing became available in secondary workshops and accounted for a shift from the specialist colouring of glass, produced by highly skilled artisans following standardised procedures, to many less specialised workshops (Boschetti 2011, 90).

Enamel

True enamelling, where powdered glass is fused *in situ* onto a metal substrate, was probably first used in northern barbarian Europe (Bayley pers. comm.). It was rarely used in Britain in the early to mid first century AD, but was applied more regularly to new brooch types which appeared in the later first century AD (Bayley and Butcher 2007, 213). There were a variety of ‘pseudo’ enamelling techniques; some of these were derived directly from the inlaid red glass of the late Iron Age; other coloured glasses began to be inset into metals including yellow and blue (figure 5.13; 9.9). Sealing wax red glass could not be used for true enamelling; if ground to a powder, the cuprite dendrites would almost certainly become heavily oxidised and the colour of the glass destroyed (figure 5.2). The ‘geometric’ Late Iron Age styled brass objects from the Seven Sisters hoard were probably some of the first objects in Britain to use true enamelling within small cast cells (discussed in chapter 7). The introduction of low-lead low-copper red glass enabled a new degree of versatility with enamels.

Figure 5. 23: Sealing wax red glass used on the bird, and low-lead low-copper enamel on a brooch; both from Birnie in north east Scotland (photographs: ©National Museums Scotland).

Summary and conclusion

For red glass in general, sealing wax red glass used in the continental La Tène period, contained no tin and very little antimony and was very similar to that from the Middle Iron Age in Britain. In Late Iron Age Britain there was a marked change in the composition of sealing wax red glass dating to the first century AD, which contained no added iron, but significant quantities of antimony; this was being used when the use of sealing wax red glass was generally declining elsewhere. Its use for large expanses of colour which were integral to the design of some Late Iron Age decorated metalwork seems unique to Britain. It was also used in smaller amounts to decorate many other high status objects, very often associated with horse equipment, as detailed in the following chapters. The possibility that this red glass was coloured locally within Britain from imported ingots of yellow glass has been hypothesised. In the later first or early second century AD, Roman low-lead low-copper red glass became the norm, and was adopted in Britain, it was used along with many other colours for polychrome enamel on metalwork, a technology which may have started in Britain with the use of inlaid red glass in the Late Iron Age, and then developed independently to become renowned within western Europe in the Roman period.

Chapter 6. The Polden Hill Hoard

Discovery

The Polden Hill hoard was found in June 1800; and first reported in *Archaeologia* in 1803 (Harford 1803, 90-93); its discovery was described in some detail:

'In the month of June last, a farmer's servant ploughing a field near the top of Polden Hill near Bridgewater, perceived the furrow become very irregular, and that the ploughshare was clogged with several rings, which were the occasion of its being thrown out of its proper track; these he very naturally concluded were the fetters of some prisoner escaped from gaol; and, on this supposition, he traced back the ground, expecting to find a file or a saw. But was surprised to pick up several scattered pieces of metal, and soon found the spot where he had struck into them, whence he took what remained. He dug about this place, (which he describes as a round hole about the size of a bushel, the bottom of which was formed of burnt clay or brick reduced to cinder). But without effect, as they were all deposited in a heap in one place'

'Polden Hill is an eminence on one side of King's Sedgemoor, a little above the village of Edington, where the evident remains of a Roman station; such as tessellated pavement, .. and a number of burnt earthen moulds used for coining money' (Harford 1803, 90-91).

As Brailsford (1975, 222) points out, there is no 'Polden Hill' in Somerset, but only the range of Polden Hills. These are a long, low ridge, extending for 20 miles and running roughly parallel to the Mendip Hills, but separated by the marshy land of the Somerset levels; the exact location of the hoard has never been verified.

For the majority of the Iron Age, the area around Glastonbury and Meare was closely linked with the far south west of England. However it is generally accepted that by the conquest period the area around the Somerset levels was part of the domain of the Durotriges; a tribal region partly demarcated today by the presence of coin types. However, it is hard to define this area precisely, as it seems to contain relatively few coins from either the Durotriges or the Dobunni (Cunliffe 1991). It is likely that the Durotriges area was named as such by the Romans, but was originally a confederacy of smaller tribal groups bordered to the west by the *Dumnonii*, and to the east by the *Belgae*; the area around the Polden Hills was probably on the periphery of this region close to the Dobunni to the north. Although the Durotriges were officially conquered by Vespasian and the II Augustan legion in AD 47; there was possibly unrest for some years following this (Salway 1981, 93; Mattingly 2006, 139, 262), especially in the northern part of the territory.

This region surrounding the Polden Hills was important in several respects; there were significant Iron Age settlements in the area, such as Glastonbury and Meare on the Somerset levels, as well as the substantial hillforts of South Cadbury and Ham Hill not far to the south west. To the north, the Mendips were an important industrial area exploited by the end of the first half of the first century AD by the Romans for the production of lead (Mattingly 2006, 139), and possibly zinc.

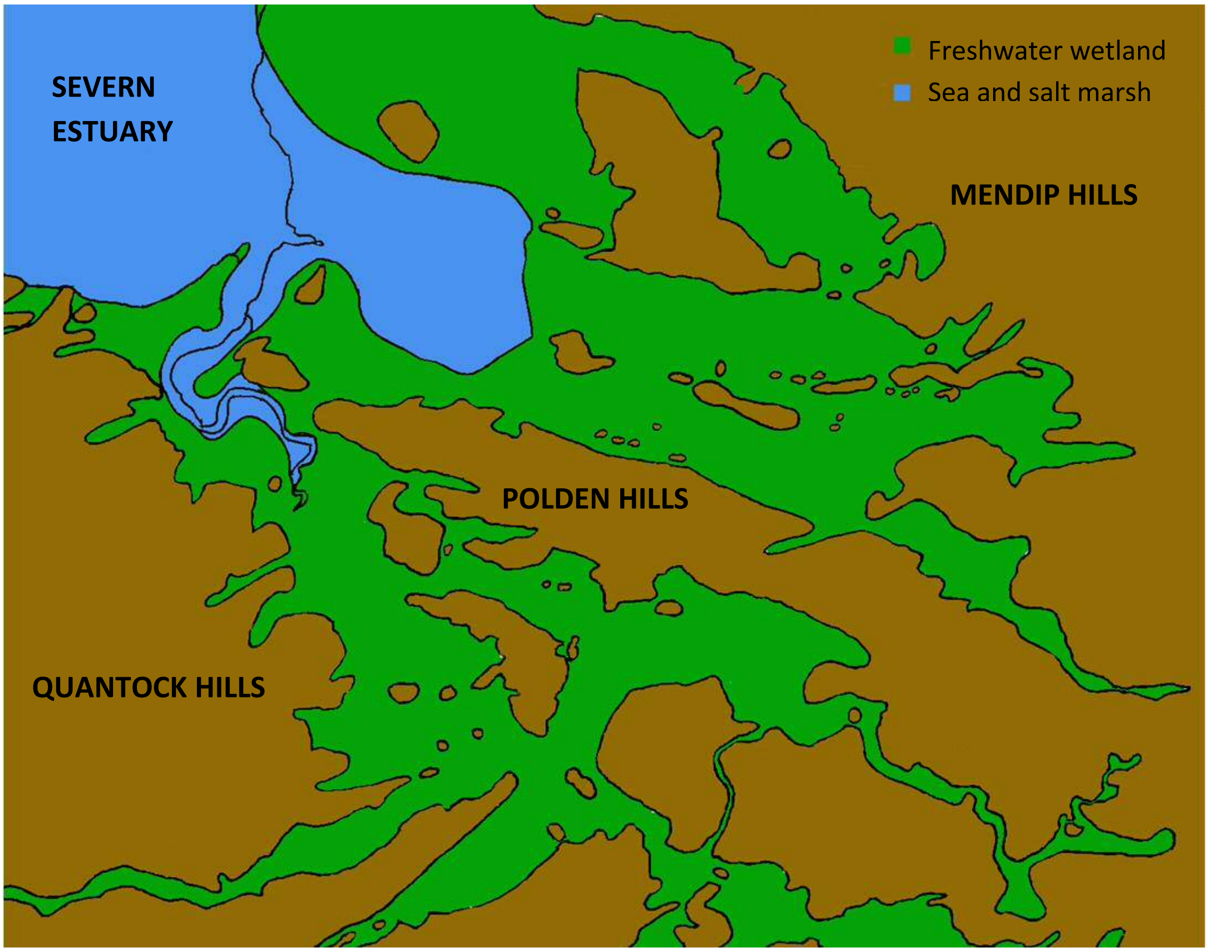


Figure 6. 1: Map of the Somerset Levels at c. AD 280, with the Polden Hills running between the Mendips and the Quantocks. Sea and salt marshes had retreated slightly since the Early Iron Age (Brunning pers. comm.).

The Polden Hill hoard has traditionally been dated to the middle of the 1st century AD or later (Brailsford 1975, 234), predominantly by the form of the brooches found within the assemblage. These include a dolphin brooch, which parallels others dated to the late 1st century AD (Hawkes and Hull 1947, 311), and a Colchester type, which could be dated to the first half of the 1st century AD (Hawkes and Hull 1947, 309) (Brailsford 1975, 232). If these dates are used, about AD 70 provides a *terminus post quem* for the hoard's deposition, and James and Rigby (1997) feel the hoard could not have been buried before this date. However, there is also some debate as to whether some items of the hoard were manufactured earlier (Brailsford 1975, 234), and Spratling believes it is more likely that the hoard was deposited about AD 50 (Spratling pers. comm.). The style of decoration and the type of artefacts comprising this hoard are paralleled in other such hoards thought to date from a similar period, such as Santon, Stanwick and Seven Sisters. Horse gear predominates: many of the objects are beautifully moulded castings, but embellished with further surface decoration such as the use of inlays of red glass and inscribed motifs. Some objects seem to have been deliberately broken, and at least some of the hoard seems to have been burned. The objects within the hoard are predominantly copper alloys, the majority of which have been made using lost wax casting.

Objects from the Polden Hill hoard

The exact number of objects in the hoard has been difficult to verify due to missing items and duplicate numbering. However, mainly with the use Brailsford's catalogue (Brailsford 1975), and by several visits to the British Museum and Frank's House, many of these anomalies were cleared up, and the number of objects accounted for in this study is 83. This takes into account duplicate numbering on the bridle-bit 46.3-22.78/79/80 (all one object), plus two broken parts of the same toggle (46.3-22.137 and 138); the iron rod is also one broken object with two numbers (46.3-22.134 and 135); the horse brooch (46.3-22.112 and 113) is one object but composed of two parts, both of which have been analysed for this study and are sometimes referred to as individual components, and similarly the torc has two numbers (46.3-22.117 and 118), and consists of iron and brass components. The head harness fragment (46.3-22.105), reported as lost by Brailsford (1975, 232) is at Frank's House, and the object described as a 'Bronze wire, from a fibula?' (46.3-22.128), which was also reported as lost (Brailsford 1975, 232), turned up amongst a group of Roman medical instruments, also at Frank's House. Brailsford also refers to a bridle-bit housed in the Bristol Museum and Art Gallery (E.1785), which is also mentioned and illustrated by Palk (1984, 95 & fig. C37).

The objects were divided into a number of different types of groups for analysis of the data; the following criteria have been used:

OBJECT	NUMBER OF OBJECTS	OBJECT TYPE/GROUP
Terret	24	Chariot/cart equipment
Linch pin	1	Chariot/cart equipment
Bridle-bit	17	Horse equipment
Horse brooch	3	Horse equipment
Strap union	1	Horse equipment
Toggle	7	Horse equipment
Head harness piece	1	Horse equipment
Pendant hook	2	Horse equipment*
Bridle spur	1	Horse equipment*
Shield boss	3	Weaponry
Chape	1	Weaponry
Iron ring	1	Other
Knobbed ring	1	Other
Iron rod	1	Other
Decorated strip	1	Other
Ferrule ring	1	Other
Brooch	6	Personal ornament
Bracelets	2	Personal ornament
Torc	1	Personal ornament
Dolphin shaped cuirass hook	3	Personal ornament*
Hammer head	1	Tool
Cosmetic/medical tool	1	Tool
Hoop fragment	3	Vessel* or chariot/cart equipment

Table 6. 1: Table of objects from the Polden Hill hoard, and categories to which they are assigned for analysis in this chapter. There are several ambiguities as to what certain objects were for; those marked with as asterisk are particularly debateable and discussed below and in relevant chapters.

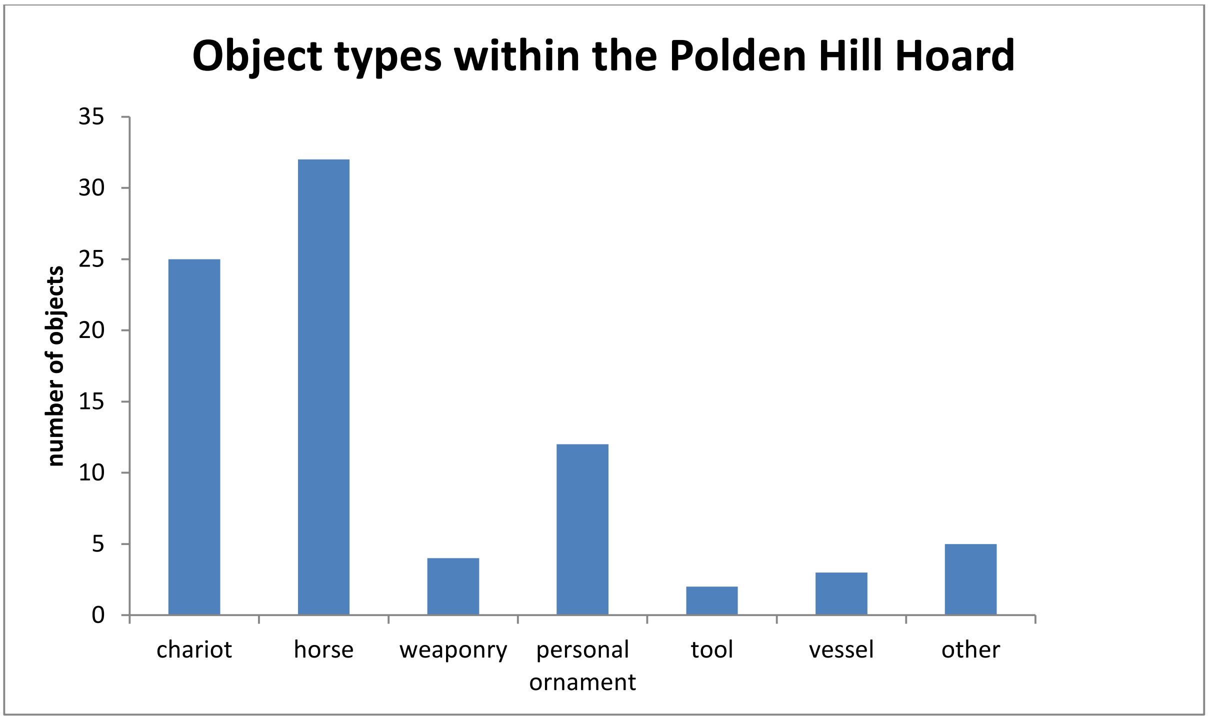


Figure 6. 2: Graph summarising the number of objects types and the categories used for analyses and discussion.

Object categories

Many of the objects occur as pairs or sets; this enables the results of analyses to be assessed not only for the hoard as a whole, but for items manufactured to be used together, such as bridle-bit pairs, or sets of terrets.

Horses and chariots or carts

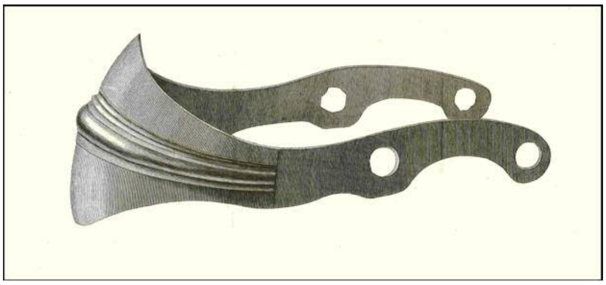
The vast majority of the objects in the hoard are related to horses and chariots or carts, such as the terrets (46.3-22.82-104 and 144), bridle-bits (46.3-22.64-81 and E.1785 (in Bristol Museum and Art Gallery)), toggles (46.3-22.136 -143), a strap union (89.7-6.77), and horse brooches (89.7-6.78 and 79 and 46.3-22.112-113). Most of these artefact types are discussed in more detail in the appendix on horse equipment (appendix 9).

The pendant (or rein) hooks (46.3-22.107-108) were described by Brailsford (1975, 230) as 'trace hooks', but with no further explanation of their use; again, this type of object has been discussed in appendix 9; they seem too weak to be involved with the attachment of the chariot, but are very likely to be related to horse harness equipment (Palk 1991, 83).

The bridle spur is unusual (46.3-22.126; Brailsford 1975, 232-3) in that unlike horse-related equipment in many of the first century hoards, it indicates horseback riding rather than the use of chariots or carts. It is very likely that riding was relatively common, but the amount of chariot/cart fittings, and the lack of positive identifiers for single riders has probably obscured the picture.

Amongst the iron objects from the hoard is an object Brailsford considered as possibly a lynch pin (46.3-22.146), although its shape could also suggest it might be an iron pendant hook (Brailsford 1975, 230).

An unusual object (46. 3-22.105), with a detailed inscribed late La Tène design, was described by Harford (1803, 92) as 'a thin brass instrument, somewhat resembling a strigil'; the drawing in his article shows a more complete object than the extant fragments in the British Museum (figure 6.3), and Brailsford interpreted the drawing as 'part of a head harness for a pony' (Brailsford 1975, 232), so this object has been included with horse associated material for this study. Its decoration suggests an object of high esteem.



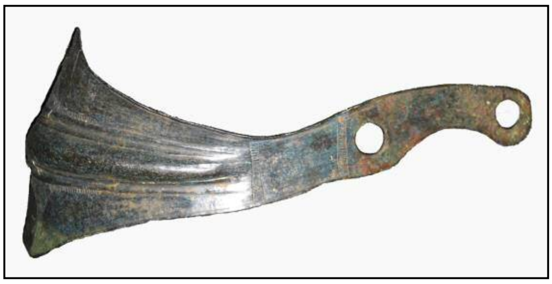


Figure 6. 3: Head harness piece (46.3-22.105) (Harford 1803 92 plate XIX, 5) and photographed recently at Frank's House; only one half is now present.

Figure 6. 4: Detail of design on head harness piece (46.3-22.105).

Personal ornament

The majority or the artefacts in this category are relatively straightforward to interpret, and include a number of distinct brooch types; a 'Polden Hill' type (46.3-22.120); a dolphin brooch (46.3-22.125; a 'Colchester' type (46.3-22.127); and three penannular brooches (46.3-22.119/121/122). There are also two bracelets and a distinctive iron and brass torc (46.3-22.117 and 118); iron was an extremely unusual metal for this category of artefact; though a recent find from Borthwick Water, in the Scottish Borders, also has iron and copper alloy components, so offers some parallel features (Fraser Hunter pers. comm.)

Slightly more contentious for this category are three 'dolphin shaped objects' (46.3-22.09-111); which were discussed by Brailsford, in terms of use (Brailsford 1975, 230). He stated that 'Fox considers these objects were harness mounts used in pairs and merely ornamental (1958, 130)'. However, it is far more likely that these were cuirass hooks used for fastening scale armour or chain mail to shoulder pieces (Webster 1995, 16), and so in this study have been classified as 'personal ornaments'.

Figure 6. 5: 'Dolphin' shaped cuirass hook 46.3-22.111.

Webster argues convincingly these objects worked as 'two 'S' shaped hooks placed back to back and hinged together at the lower end by means of a rivet passed through their overlapping, flat, discoid terminals and secured' (Webster 1995, 16). Fox illustrated several examples (Fox 1958 pl 75); one is from a 'Roman villa' in the shape of a fish; the others that he cited (including those from Polden Hill) he described as 'Celtic examples'. Fox believed these dated to the first century AD, but suggested the 'Celtic' examples were 'copied or derived from earlier Roman imports' (Fox 1958, 130). It is likely that their origin is far more complex, and probably originally derived from northern European armour, originally used by Celtic Iron Age warriors in Europe, and adapted by auxiliary troops and thereby adopted within the Roman army (Chapman pers comm.) There is an example from the Roman fort at Usk described by Webster as 'wholly Celtic in its artistry and its iconography' (1995 18). Similar hooks are also present in the Stanwick/Melsonby hoard (MacGregor 1962, 22; 42).

Weaponry

There are four objects which are parts of weapons; three of these are shield bosses, two of which are very similar and relatively plain except for a number of inscribed concentric grooves (46.3-22.115 and 116). Brailsford believed these were shaped by 'spinning', and the concentric circles do imply the use of a lathe. The third shield boss is more elaborate and is decorated on its flange with a running scroll design (46.3-22.117) (Brailsford 1975, 228).

Figure 6. 6: Shield boss 46.3-22.114 (Harford 1803 91 plate XVIII, 1) and 46.3-22.115.

The other ‘weapon’ is a decorated semi-circular shaped sword chape (46.3-22.123) (figure 6.18).

Tools

In this study, two items have been categorised as tools; these are a hammer head (46.3-22.133), and a copper alloy object which could be a medical or toilet instrument (46.3-22.128).

‘Others’

Five objects proved impossible to categorise at all. These include a very unusual ring (about the size of a bridle-bit ring), but with seven evenly spaced knobs on part of one face (46.3-22.106). There is also part of a thick bronze strip with cast in decoration (46.3-22.132), a bronze ferrule (46.3-22.124), an iron ring (46.3-22.145), and two fragments of an iron rod (46.3-22.134-5).

Figure 6. 7: Knobbed brass ring (46.3-22.106); 5.62 cm diameter with seven knobs and a plain underside; decorated cast bronze strip (46.3-22.132); 5.1 cm in length.

Vessels

The hoop or strip fragments (46.3-22.129/130/131) were formally described as the remains of a nave band (Brailsford 1975, 232). However, there is the possibility that these were hoops on a wooden vessel (Jody Joy pers. comm.). The use of vessels is becoming a more accepted interpretation for many metal strips or components, as present in the Seven Sisters Hoard (Davis & Gwilt 2008, 149), the Santon Hoard (Spratling 2009), and the Stanwick/Melsonby hoard (Fitts *et al.* 1999, 40).

Figure 6. 8: The hoop or strip fragments (46.3-22.129/130/131).

The width of each strip (55mm) is very similar to that of the iron bands from vessels from the Marlborough and Aylesford graves (Fitts *et al.* 1999, 41-3).

Methods of analysis and interpretation

The methodology employed below has added further to the material analysis by investigating the various physical attributes of each object against its type and the composition of the metal, something which cannot be done purely by visual examination.

Initially objects were looked at solely by type to gauge a degree of difference, then objects of different types were assessed together to see if more relationships could be seen. Detailed analysis was also undertaken in relation to the composition of inlaid red glass; this gave a less varied and complex data set than the metallurgical analysis but could be examined in conjunction with the metal composition where relevant. When several factors were taken into account, an increasing picture of complexity emerged; but some patterns between various features could be discerned.

Metallurgical analysis

General trends

Extensive analysis was carried out on the majority of the artefacts from this hoard; where possible samples of the copper alloy objects were taken with a 0.9mm drill bit and then mounted in resin and polished for metallurgical examination. This was principally carried out using scanning electron microscopy with energy dispersive spectrometry (SEM EDS) to determine major elements and scanning electron microscopy with wavelength dispersive spectrometry (SEM WDS) for the quantification of minor and trace elements. The red glass (where extant) was also sampled and analysed, predominantly by SEM EDS; this relatively detailed data set enabled direct comparisons of the compositions of different metals and glass used within the hoard, but also allowed for evaluation and comparison of similar objects from other sites.

It was agreed with the curator at the British Museum that a small number of the copper alloy objects were not suitable for metallurgical sampling; these are shown in grey in the graphs below.

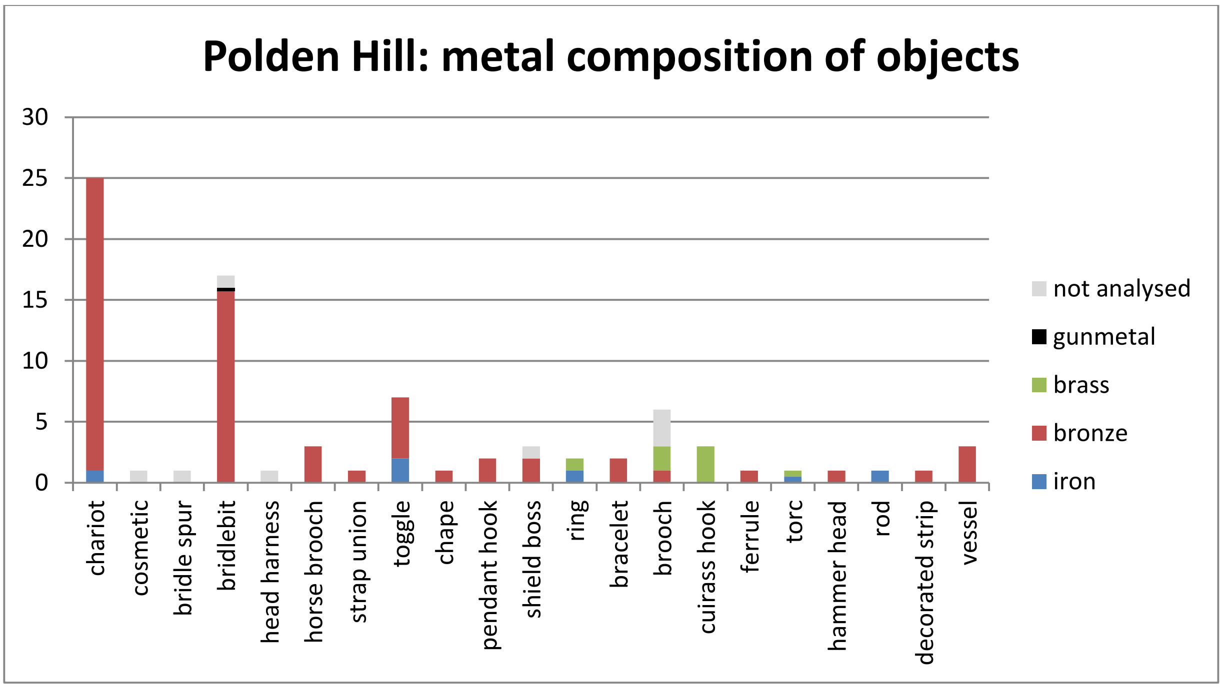


Figure 6. 9: Objects within the Polden Hill Hoard and their composition.

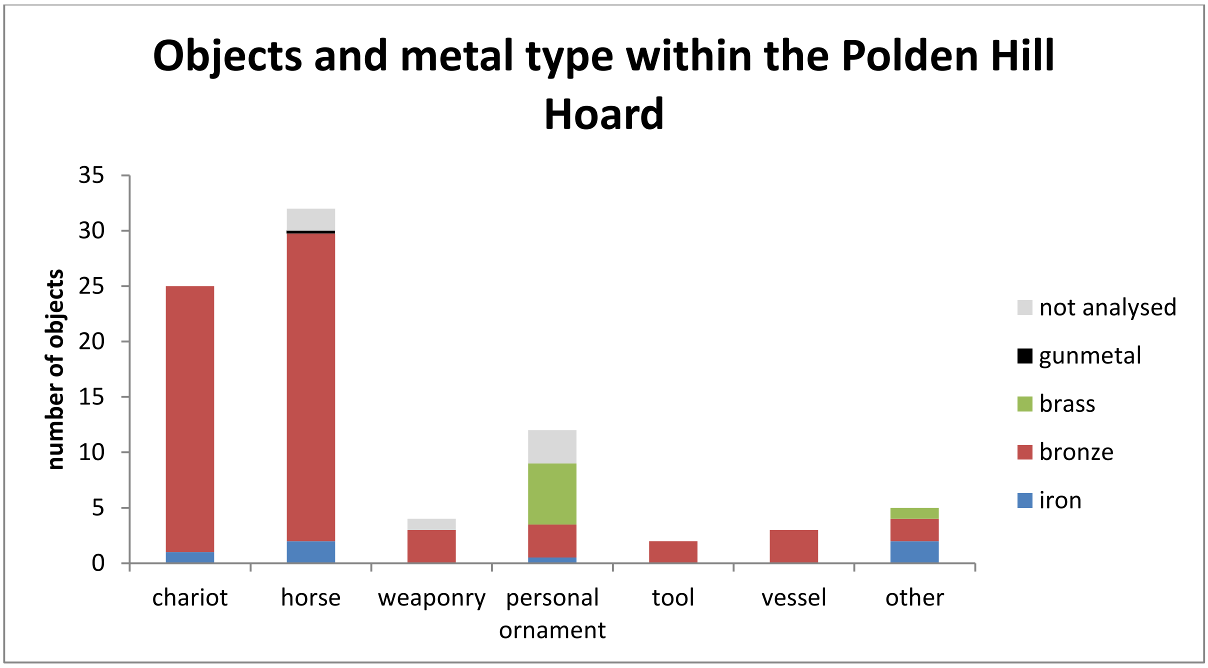


Figure 6. 10: Object types and different metals within the hoard; all the 'not-analysed' artefacts are of an unspecified copper alloy.

The vast majority of the objects analysed are tin bronze, with a small but significant number of brass objects, all of which were used on the person, except for a unique knobbed ring, which has been categorised as 'other' (figure 6.7). There are several iron objects, which form a minor part of many of the groups; in most cases the iron objects could have been made of copper alloy and/or iron, and do not form a very significant overall constituent of the hoard. Interestingly there is only one gunmetal component, and this is from one link on a bridle bit (46.3-22.64), it contains a similar quantity of tin to the other components, but has additional zinc in the alloy; the rest of this bridle-bit is tin bronze.

The material composition of this hoard follows a pattern seen in the majority of native style Late Iron Age objects from the other hoards or groups of objects which have been studied, e.g Stanwick (MacGregor 1962; Dungworth 1996 and 1997) , Camerton (Cowell 1990), Seven Sisters (Davis and Gwilt 2008) and the other hoards within this study, where the use of leaded copper alloys or gun metals are rare amongst horse and chariot equipment, weaponry and feasting and drinking gear, (which predominate much of the hoarded material). More mixed alloys tend to occur in more 'Romanised' artefact types.

The similar metallurgical nature of the hoard is easily visible from the copper and tin scatter diagram (figure 6.11). The object with a lower tin and higher copper content is the ferrule or small ring; this is a wrought object and the use of this alloy makes sense here. However, other wrought objects such as the shield bosses have alloys comparable with all the cast objects, where the range of tin content from c.6%-14% shows little deliberate discrimination in composition for later manufacturing technique.

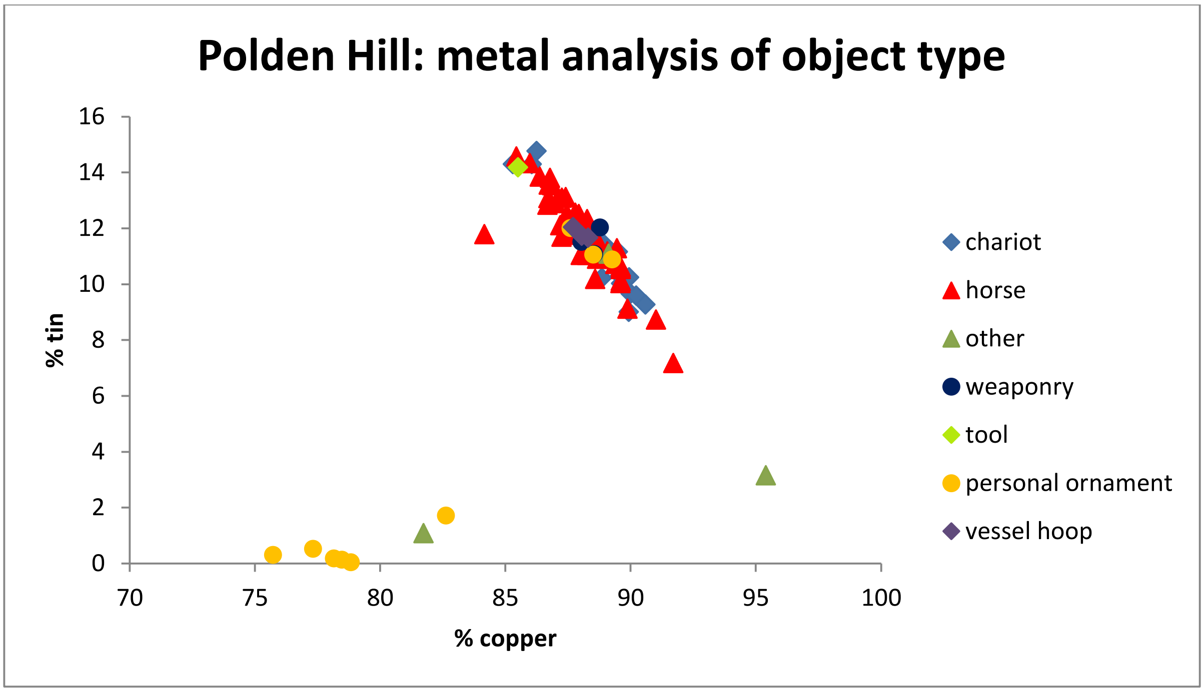


Figure 6. 11: Scatter plot of copper and tin contents of the analysed components of the Polden Hill Hoard; the majority are tin bronze; the small separate group mainly comprising personal ornaments, are brass.

Bronze artefacts in the hoard

Minor or trace elements from Iron Age and early Roman material have been used to group artefacts in the past, e.g. for material from Wessex, (Northover 1984, 1987, 1991a), from northern Britain (Dungworth 1996, 1997), and from Llyn Cerrig Bach (Anheuser *et al.* 2007). The presence of such elements as arsenic, nickel, silver, lead and zinc have been examined in detail, as they tend to occur in greater proportion and frequency in Iron Age artefacts than in Roman ones (Dungworth 1997, 6.6). Analyses of the Polden Hill material suggested that arsenic could be a relatively useful discriminator within the assemblage; it has been found as a significant impurity in many Iron Age bronzes (Dungworth 1997, 5.3.6), but is largely absent from Roman copper alloys. Although many Iron Age artefacts do not contain high levels of arsenic, the crucial difference is that c. 85% of all Roman copper alloys contain less than 0.1% arsenic (Dungworth 1997, 5.3.6), implying that in terms of manufacture as well as in style, that the majority of objects within this hoard are Iron Age in character (Davis and Gwilt 2008). The reason for the presence of arsenic in the bronzes is not entirely known; it could be connected to the ore sources or the smelting process (Dungworth 1997, 5.3.10), though Ixer and Budd (1998, 36) suggest it is more likely to be the latter). Whatever the origins, arsenic, when used as a discriminator, can help the interpretation and understanding of this group as a whole.

Although the majority of the objects analysed fall into a single group in the copper versus arsenic scatter plot (figure 6.12), the personal ornaments are easily distinguished by their major alloying components: copper and zinc (red circle); also two ‘other’ objects are outliers; the knobbed ring and the ferrule. However, there are also two separate groups showing both higher and lower than normal arsenic levels (figure 6.12). The high arsenic group (blue circle) are predominantly bridle-bit components from 46.3-22.77 and 46.3-22.78-80. This is a bridle-bit pair where both the bits were deliberately broken in antiquity, (only one link piece and one ring are extant from 46.3-22.77). The rings from this set are all within this higher arsenic group and all have a larger diameter than any of the other bridle-bits' rings. The other object from here is one of the shield bosses (46.3-22.115).

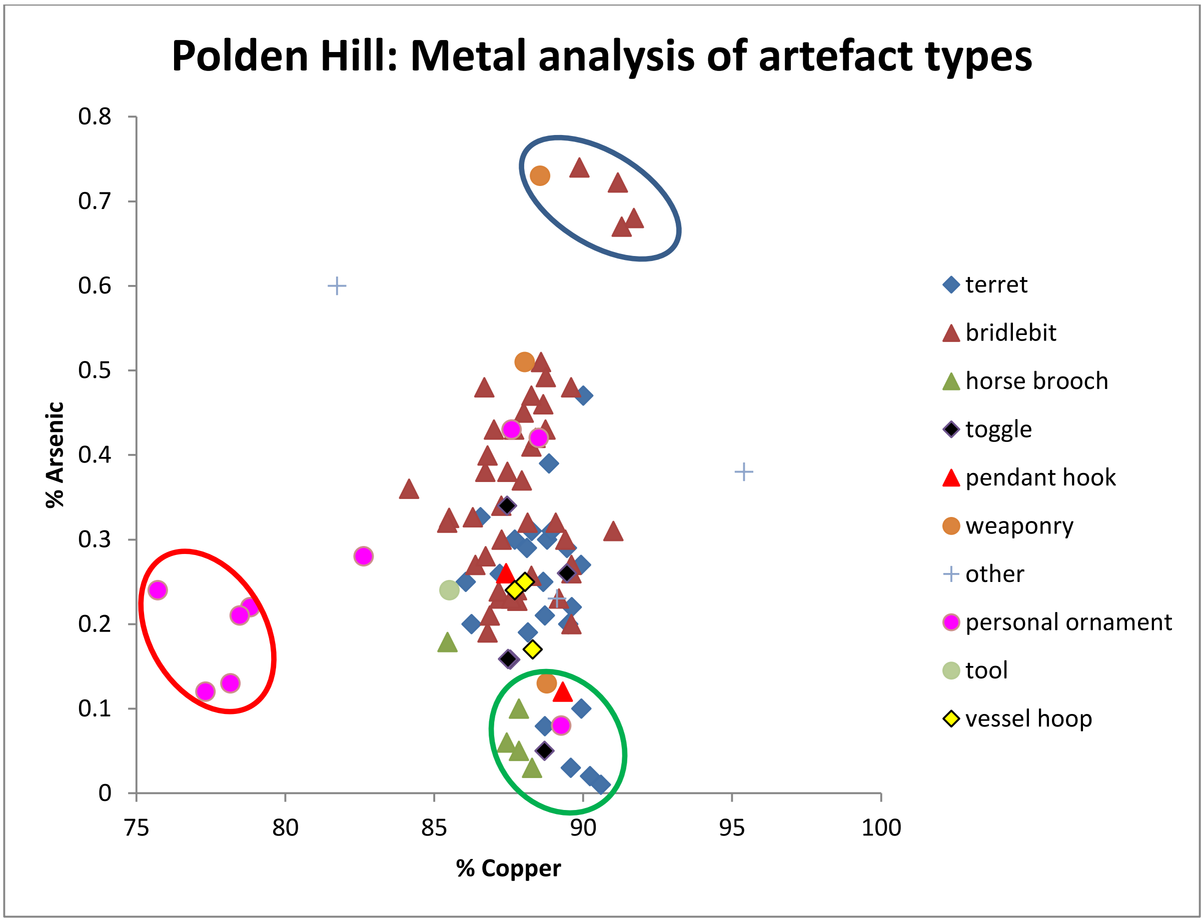


Figure 6. 12: Scatter diagram of copper versus arsenic; the 'high arsenic' (blue) and 'low arsenic' (green) groups are circled. Brass objects are circled in red.

The lower arsenic group (green circle) is also distinct; it contains three terrets (46.3-22.101/103/104), which along with 46.3-22.89 form one of the two discrete 'sets' of four terrets in the hoard (Brailsford 1975, 224), and as with the bridle-bits mentioned above, form a group by composition and style. This low arsenic group also contains all the highly decorated large horse brooches, and the strap union (89.7-6.77-79 and 46.3-22.112/113). There is one outlier with a higher arsenic value from the horse brooch group, and this is 46.3-22.112, one half of the large two piece horse brooch (figure 6.67); this component is also the only object analysed to contain Roman style red glass as well as Iron Age sealing-wax red glass (figure 6.68; 6.70), so is very unusual. Other than the terret and horse brooch groups, there are also a number of single items; one bracelet form a pair (46.3-22.148); one pendant hook from a pair (46.3-22.108); one shield boss from a pair (46.3-22.116) and one toggle from a set of four similar items (46.3-22.136). Two further single terrets, (46.3-22.99 and 46.3-22.100) are also in this group; the latter shows many individual characteristics amongst this object type.

It is interesting that so many pairs of objects have slightly different compositions; as this must be related to the manufacture of the pieces; it could imply that for sets or pairs of cast objects, one is acting as a prototype, and possibly as a former for manufacturing the moulds for subsequent near identical pieces. This could imply that the original cast objects themselves rather than wooden patterns were used (Foster 1980) which makes sense in creating sets or pairs of unique objects. Most Iron Age objects seem to be deliberately distinctive 'there seems to be a marked emphasis on novelty and innovation in the decorations applied to Iron Age objects' (Garrow *et al*. 2010), and this mode is continued into the 1st century AD. This pattern of composition is discussed further (below) in relation to terrets and bridle-bits.

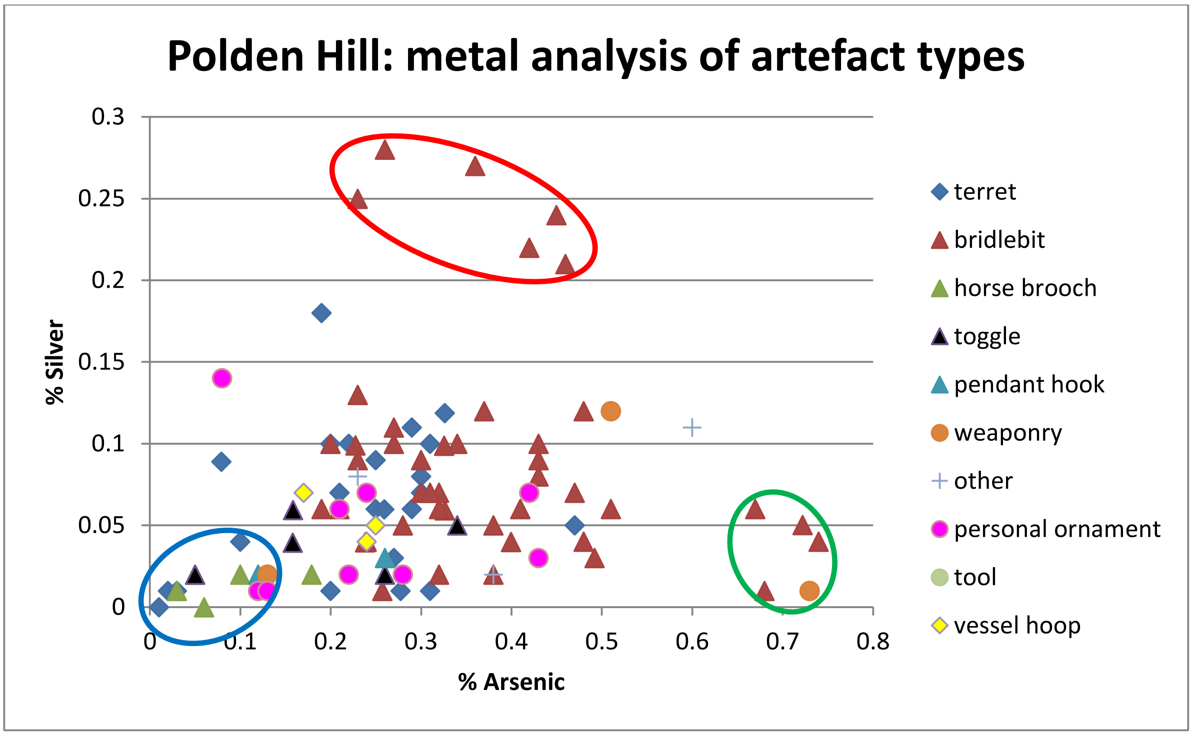


Figure 6. 13: Scatter diagram of arsenic versus silver; the 'low arsenic/low silver' (blue), the 'low silver/high arsenic' (green) and the high silver (red) groups are circled.

The groups highlighted in figure 6.13 again show some compositional consistency. All of the objects discussed above with low arsenic values (figure 6.13 blue circle) also have low silver values confirming this as a distinct compositional type. This low arsenic/low silver group contains two of the three brass cuirass hooks (46.3-22.9 and 10), which have a distinct composition from the third one (46.3-22.11); this again fits a pattern observed for groups or pairs of objects where one often appears analytically distinct.

The high arsenic group (green circle) is the same as in the previous diagram (blue circle in figure 6.12), but there is also a group containing high silver (red circle). These are all bridle-bit components; one is the bridle-bit link containing high zinc (46.3-22.64); but there are three links from the bridle-bit set (46.3-22.72 and 46.3-22.74), a pair with a very distinct and well preserved bluish green patina, plus two components from another unusual bridle-bit (46.3-22.71), in that it has inlaid pelta shapes cut into the wings of the links and in this way is distinct from its 'pair'.

Other potentially significant trace elements derived from copper ores (Ixer and Budd 1998, 36), which are often present in Late Iron Age bronze artefacts are lead, antimony and nickel; the latter two seem to be relatively insignificant within this hoard, which could imply a limited number of sources exploited or traded for the manufacture of this group of artefacts.

Some objects can possibly be grouped by the fact that they show virtually no trace elements; a pattern such as this was seen in the material from Llyn Cerrig Bach (Anheuser *et al.* 2007), where certain groups of object types, primarily casket ornaments, coiled mounts, globular cauldron fragments and nave hoops, were made from a 'purer' bronze than the majority of items in the hoard (Macdonald 2007, 166). Macdonald (2000) had earlier hypothesised that the casket ornaments and coiled mounts, in particular, were relatively late in date on stylistic grounds, and a tentative interpretation of the analytical data seemed to back this up. There was a reduction in arsenic content, but the objects also showed distinctly less iron, antimony and nickel. This potentially reflects a shift in smelting practices between Late Iron Age and Roman technologies, as the latter, in general, has much lower impurity levels (Dungworth 1997, 6.6). For the Polden Hill hoard, it is impossible to draw conclusions for chronology or tradition via the presence and absence of trace elements; but does discriminate some groups of objects which presumably had a different *chaîne opératoire* (Lemonnier 2002), and thereby a different origin and life history.

Further examples of differences when looking at trace and minor elements can be seen with the cuirass hooks, which, unusually for objects in this hoard, contain antimony. The toggles have few detectable trace elements, as do the horse brooches and strap union. The one terret which contains significant antimony is 46.3-22.100 (figure 6.61), it is very unusual in several respects and discussed below. The bridle-bit pair 46.3-22.72 and 46.3-22.74 containing antimony has a very distinct patination, so these objects are slightly unusual within the hoard as a whole. The scatter diagrams (figure 6.14; 6.15) give an indication of this by looking at iron and antimony levels.

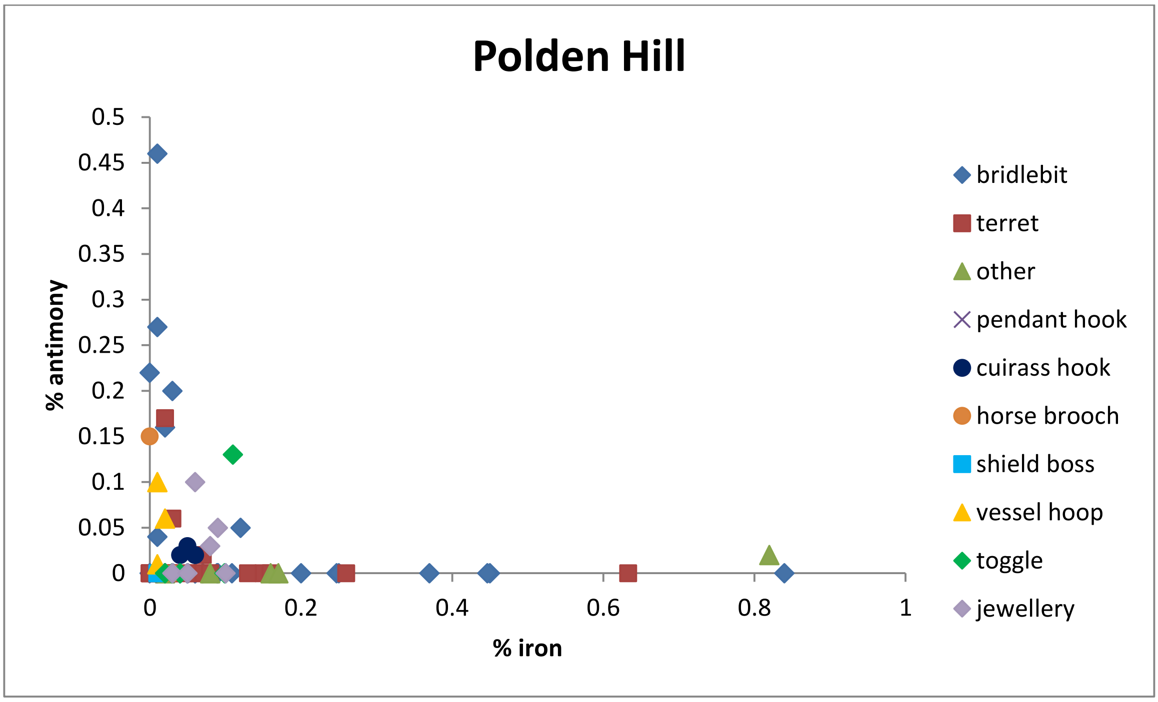


Figure 6. 14: Iron and antimony levels for all objects in the hoard.

The bridle-bit components and terrets show the largest variation in both major and minor/trace elements, but when these are taken out, some patterning of other object types can be seen.

The cuirass hooks and vessel hoops form distinct groups with higher antimony values; as does one of the bracelets, a brass dolphin brooch and the torc. The horse brooches (except for 46.3-22.113, part of the two piece brooch), pendant hooks and shield bosses have very few trace elements (no detectable antimony and less than 0.05% iron).

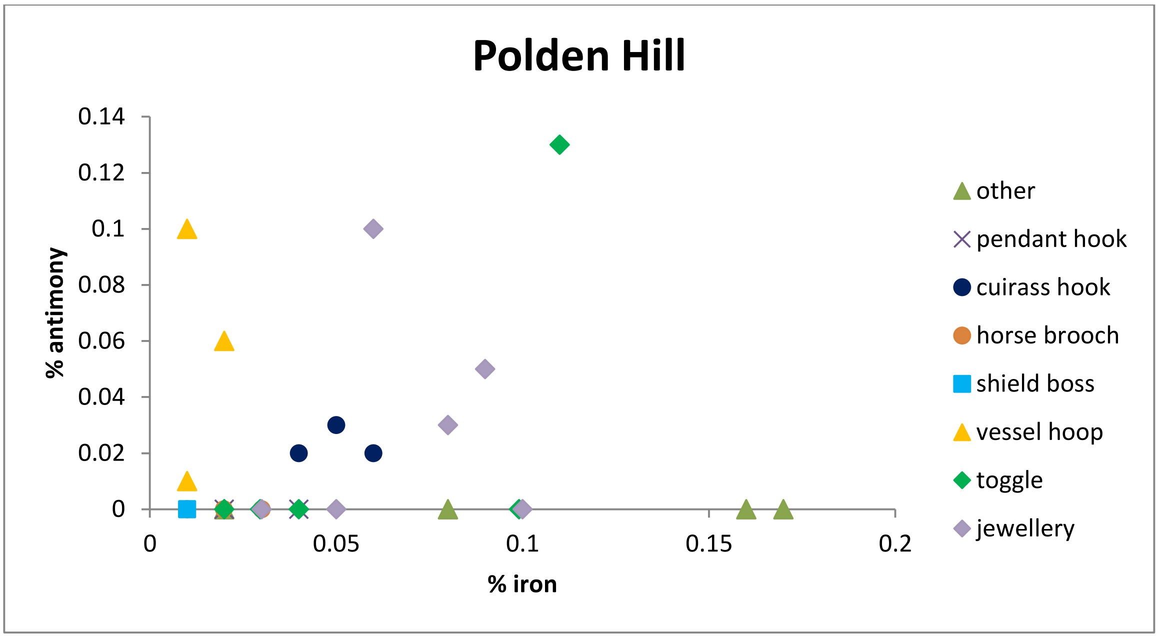


Figure 6. 15: Iron and antimony levels for objects other than bridle-bits and terrets.

Brass artefacts in the hoard

The most distinct groups in terms of major alloying constituents are the personal ornaments; a large proportion of those analysed were brass, i.e. a copper-zinc alloy. As with many brooches from the first century AD, the earlier types (Nauheim derivative, Colchester etc) tend to be either relatively pure brass or pure bronze (Bayley and Butcher 2004), and this pattern is repeated here. However, it should also be noted that in this hoard as a whole, brass is reserved for objects worn on the person; this is a phenomenon seen on other personal items for the Late Iron Age such as the Wraxal type collars and massive armlets (Hunter 2007; Joy 2014). This is significant in displaying personal identity, which needs to be considered in juxtaposition to the group or communal identity, which is represented through the display and decoration of horse equipment, or that for feasting/drinking, where group or tribal identity could be perceived as predominant in terms of physically marking or signalling allegiance. The torc is particularly unusual in being made of iron with brass wire decoration.

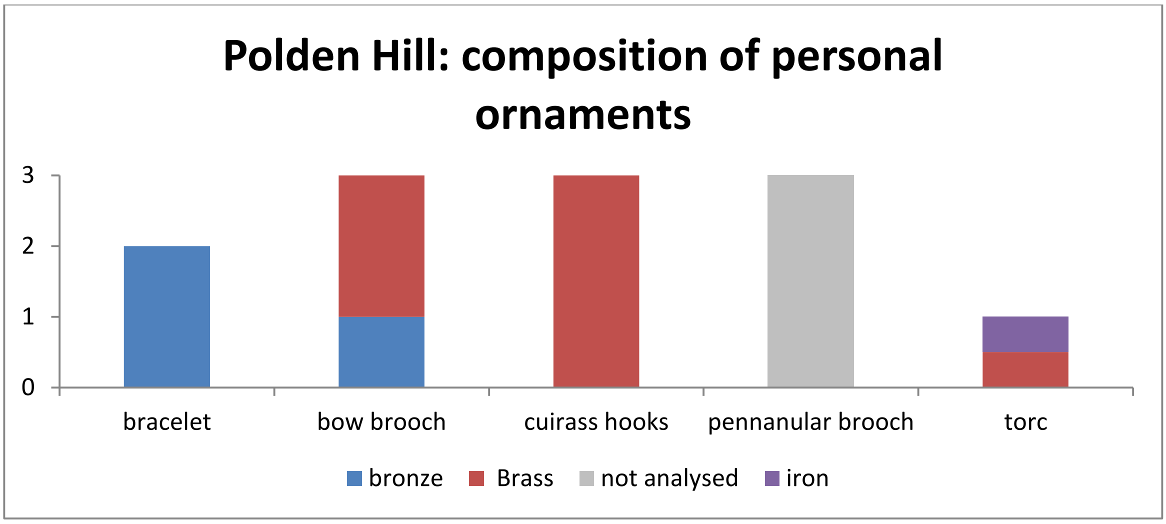


Figure 6. 16: Distribution of metal types for ornaments worn on the person.

Decoration

The diverse range of objects is echoed by the range of decorative techniques applied to them. Most of the categories have similar types of applied decoration, but this is not the case for horse and chariot equipment, which show considerably more variation.

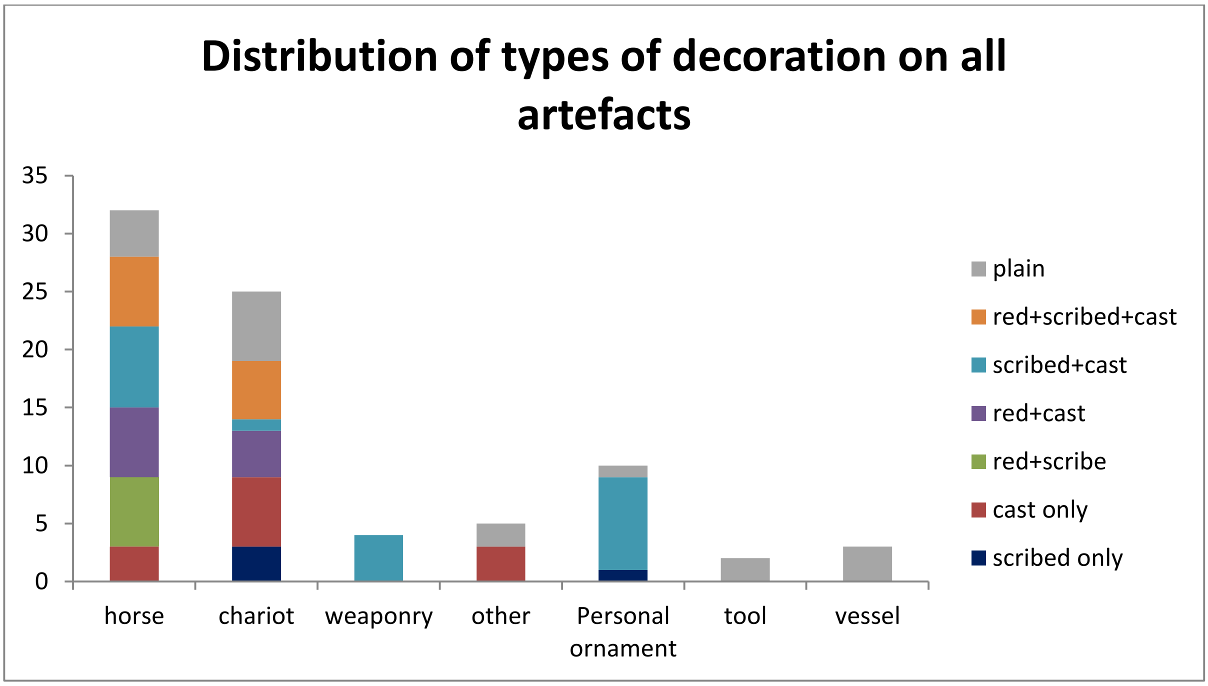


Figure 6. 17: Combinations of decorative techniques applied to objects within the hoard.

Objects and decorative features

Weaponry

The sword chape is similar to two chapes found at Hod Hill (Brailsford 1975 234). It has a small decorative cast motif incorporating ring and dot decoration which form part of a keeled roundel motif (Joy 2010), and some small punctulations similar to those on some of the bridle-bits and terrets.

Figure 6. 18: Chape 46.3-22.123

Harford, (1803, 90) stated that the shield bosses seem 'to have been intended for a breast-plate for a woman', of more relevance is the comment that 'it is of very good workmanship'. In this respect these objects do exhibit very fine craftsmanship and artistry. The flange on the decorated boss 46.3-22.114 has a classic insular Late La Tène motif in the form of a running scroll with four elaborate whorls, each surrounding a hole, which were the original points for attaching the boss to the shield. This design has been directly compared to others from southwest England including the collars from Wraxall and Llandyssul, and the ornament found on pots from Glastonbury (Brailsford 1975, 228; Megaw 1970 no. 279). The other two shield bosses appear to form a pair, and look to have been formed by 'spinning' the metal on a lathe, to produce a thin and uniform shape. These bosses also have four equally spaced holes for attachment to the shield (figure 6.6).

Personal ornaments

The decoration on these artefacts is all 'cast in' as part of the manufacturing process. The Polden Hill type brooch is beautifully designed and made, but this appears in contrast to the annular brooches which have very little ornament. The brass metal, from which many of the objects were made, would have stood out from a distance and appeared golden in colour compared to tin bronze. Here the colour and shine of the metal might have indicated more in terms of design than close stylised workmanship.

Figure 6. 19: Polden Hill style brooch 46.3-22.120 and cast and scribed decoration on bracelet terminal 46.3-22.148.

Vessel hoops

The vessel bands, if that is what they are, would have had a functional purpose in holding wooden staves in place, and be decorative by the appearance of bronze-coloured metal on wood. There is no further decoration in these strips.

Other

Apart from the knobbed ring, this group are undecorated and largely made of iron.

Tools

The medical instrument is finely made and has lathe turned decoration on its shaft.

Figure 6. 20: Lathe turned decoration on the shaft of 26.3-22 128

Horse gear

In general the horse gear has by far the largest variation and most complex motifs, culminating in the production of the stunning decorated horse brooches and strap union, which are some of the finest extant objects of late insular La Tène art.

Horse gear with inlaid decoration

Pendant hooks are the only objects in the hoard which retain attached decoration other than red glass; (though the cuirass hooks may also have had some type of material pinned to their terminals which is now lost (figure 6.5). The white decorative bead on these objects is a hard chalk-like calcium carbonate (possibly aragonite/coral), which were pinned into cast holes. As with many of the other horse related material, the pendant hooks show a high degree of carefully executed decoration. These objects, as with the horse brooches and strap union, are flat and undecorated on their reverse face, indicating that they were only to be viewed from one side, but also that the metalworker concentrated on the decorative affect on one side only, and in many respects undertook a two dimensional casting operation as far as moulding and shaping were concerned.

Figure 6. 21: Front and reverse of pendant hook 46.3-22.108, with calcium carbonate 'bead' riveted to the metal substrate.

Only pieces related to horse and chariot equipment have inlaid red glass. The distribution of this type of decoration can be seen clearly in the graph below (figure 6.22); and will be discussed in detail later in the chapter.

Twenty six out of fifty six of the horse related objects were once decorated with red glass. Of the other horse pieces, seven of the objects are iron, none of which are decorated. Twenty-two of the objects from the hoard still contain red glass; much of this has survived as a pale green powder, with only very small areas of red still extant. Some bridle bits have lost their inlays completely, particularly from circular holes drilled into the bronze surface (figure 6.72).

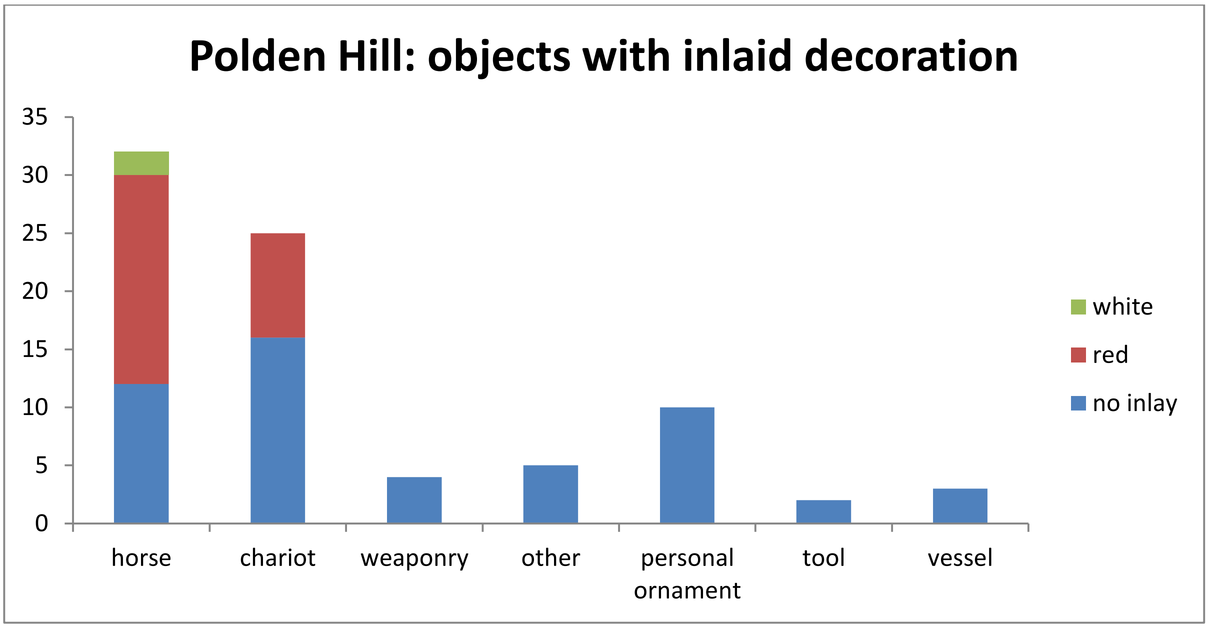


Figure 6. 22: Distribution of Inlaid decoration on objects from the Polden Hill hoard

Analysis of object types and groups

Horse Equipment

Of the 83 objects within the Polden Hill hoard, the vast majority (57) are for use with horses and chariots or carts.

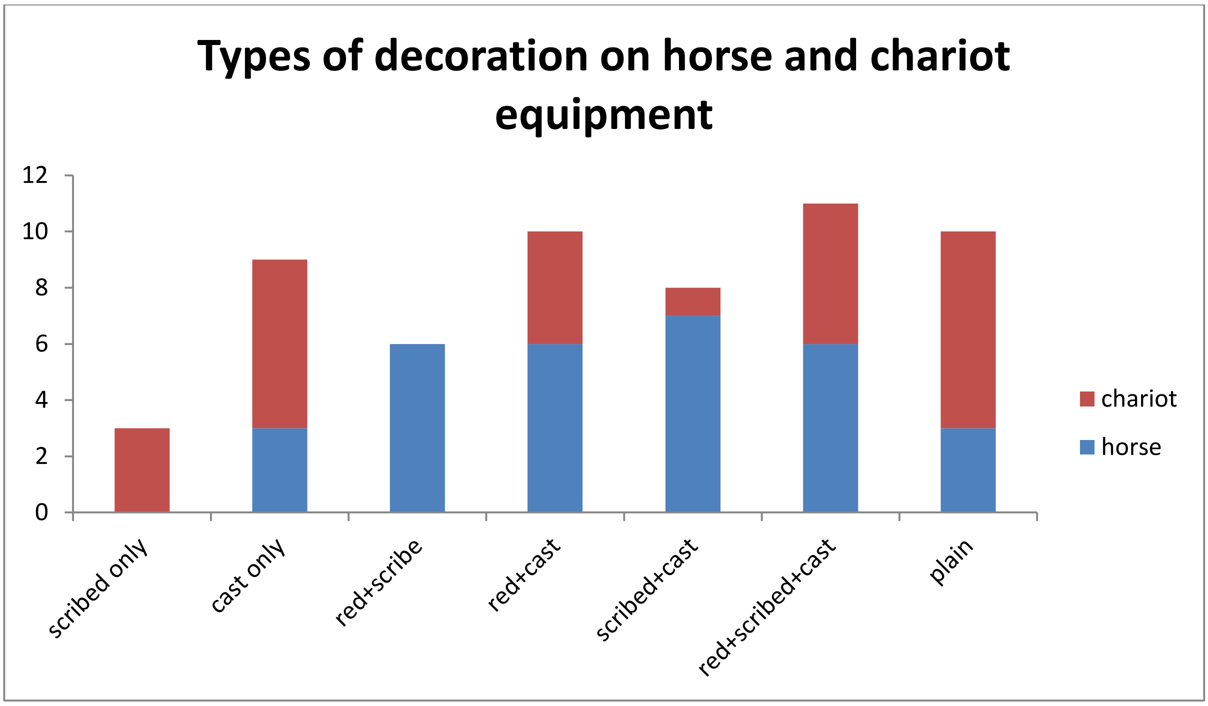


Figure 6. 23: different types of decoration on the chariot and horse equipment within the Polden Hill hoard

Not surprisingly, considering the proportion of object types, the majority of the inlaid objects are bridle-bits and terrets; many of these have both glass and metal analyses to contribute to the interpretation of the artefacts from the hoard.

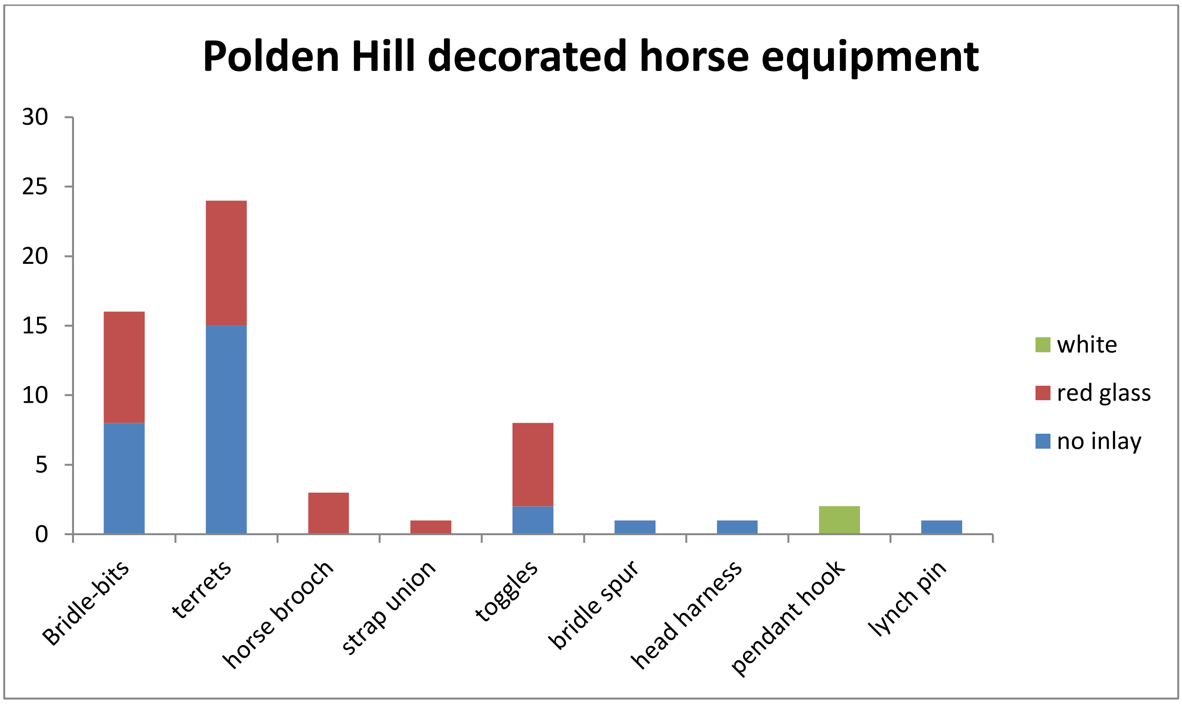


Figure 6. 24: Decoration on horse gear from the Polden Hill hoard: 27 out of 57 of the horse pieces have been decorated with red glass inlays.

The graph above (figure 6.24) shows the range of horse and chariot associated equipment in the hoard, and the numbers that have inlaid decoration. The lynch pin, and two toggles are iron, and are plain; the rest of the artefacts are bronze. Therefore all the horse brooches, the strap union and bronze toggles are decorated with red glass; these classes of object also show the most complex combination of forms of surface decoration including cast in and incised motifs. The majority of the terrets, plus the lynch pin show no surface decoration; interestingly these are items of equipment used on the chariot or cart rather than on the horse itself. Although several of the bridle-bits do not contain red glass, all except one pair have some type of cast-in decoration on their 'ears 'or 'lobes'. Only one pair of undecorated bridle-bits seem the exception to this rule (nos. 46.3-22.64 and 46.3-22.73; figure 6.36).

Metallurgical analysis and decorative features on horse equipment

The following diagrams combine decorative features with metallurgical analysis, especially that of trace elements, in order to interpret connections and differences between various objects which are often similar in type and appearance but which detailed visual examination also show have subtle visual distinctions.

It can be seen from figure 6.25 that the terrets, and especially bridle-bits show the largest variation in metal composition for inlaid pieces. The toggles, pendant hooks and horse brooches/strap union form much tighter groups of artefact type. The one obvious exception is the same half of the horse brooch with the 'Roman' style glass (46.3-22.112), which is separate to the rest (the black square towards the top left hand corner).

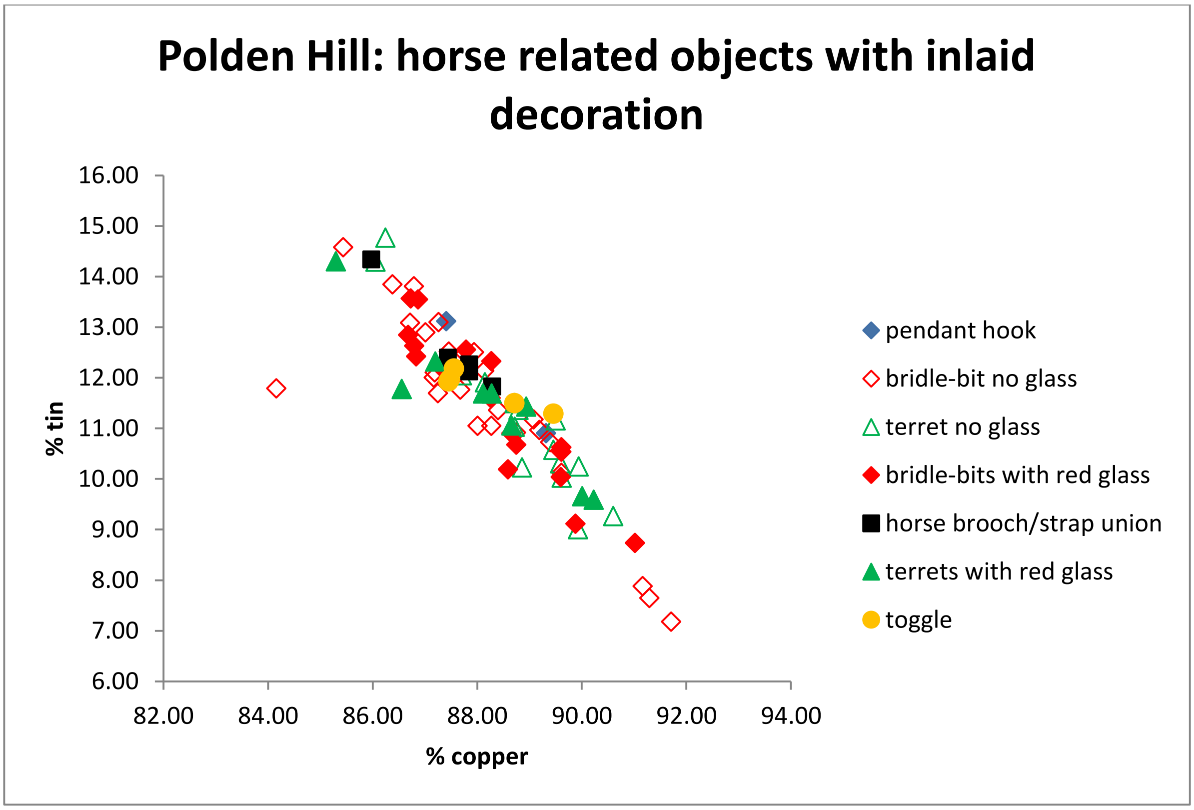


Figure 6. 25: Copper and tin values for horse equipment which has (or had) red glass, and for those with no inlay.

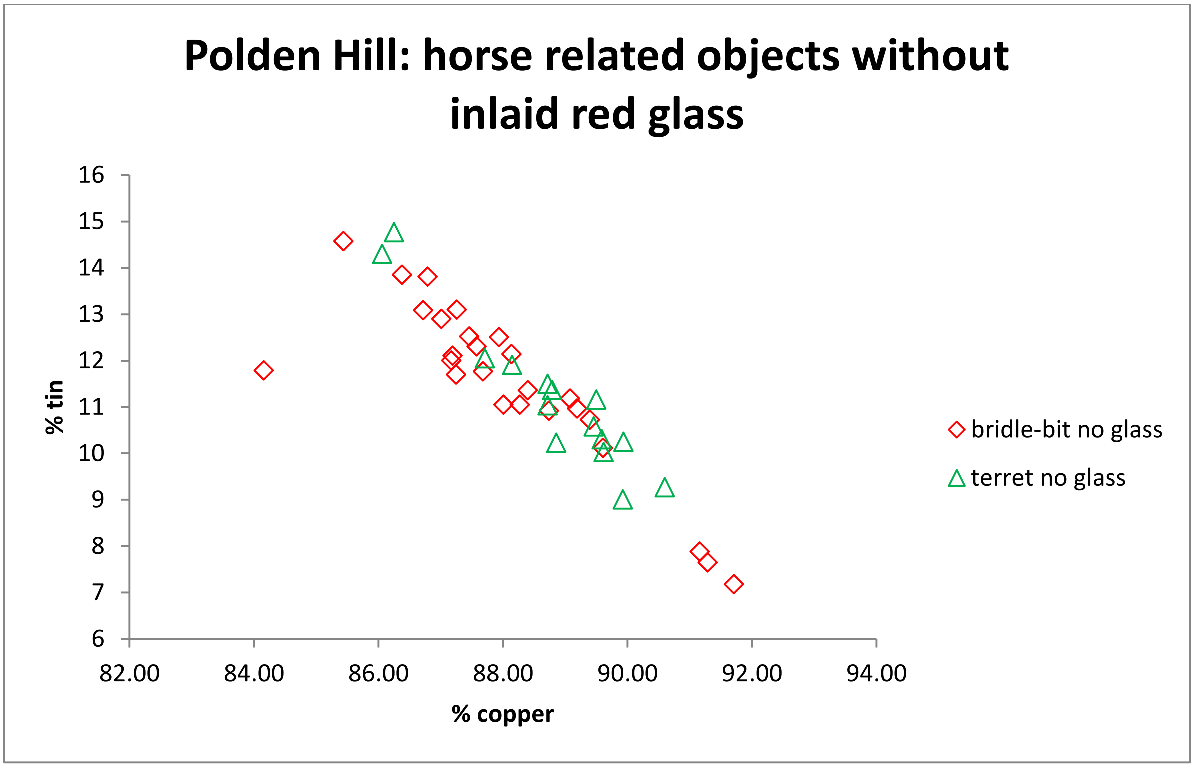


Figure 6. 26: The pattern for undecorated terrets and bridle-bits can be seen in the scatter diagram above; The bridle-bits cover the entire compositional range of tin bronze from the hoard, whereas the terrets seems to form one major group, with two outlier, 46.3-22.84 and 144; two plain terrets from Brailsford's 'type 1' group (1975, 223).

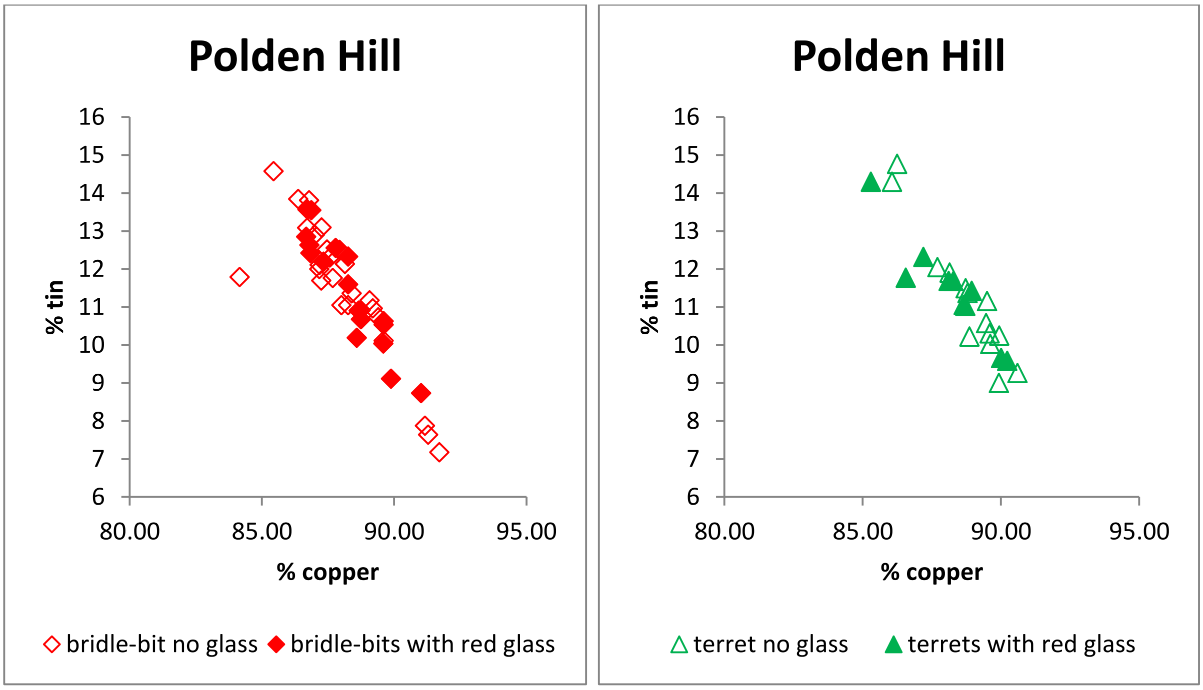


Figure 6. 27: The above diagrams confirm that the bridle-bit components and terrets with glass inlay all fall within the main concentration of artefacts for both types.

This implies that for the use of major elements there is no particular discrimination made on the part of the metal worker as to whether decorated pieces were to be made of a specific tin bronze alloy, and in this respect is not casting particular objects from particular batches of metal. The two outlying undecorated terrets are the only two objects where it is possible to see a different casting episode on the basis of tin and copper content alone (46.3-22.84 46.3-22.144; and 46.3-22.88 (type 1b, 1c and 2a), though several would have taken place.

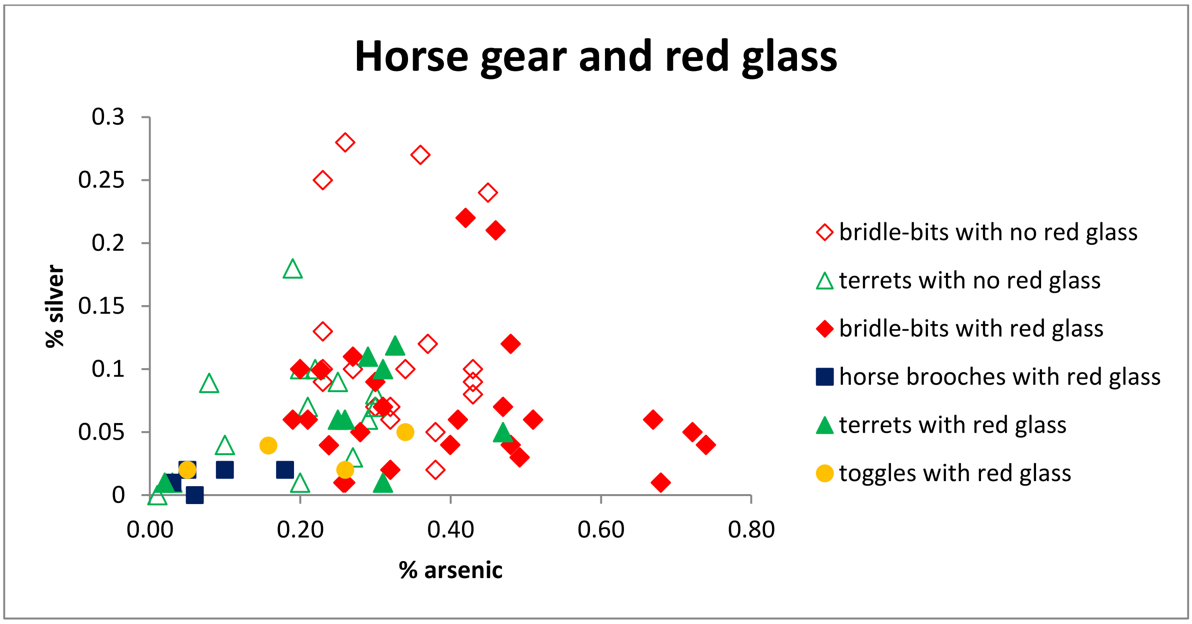


Figure 6. 28: This scatter diagram shows a very mixed picture, but some traits do occur. The blue circle depicts a group of decorated terrets with very similar arsenic levels. These include the terrets with post-casting excised triangles and most of the single large black patinated terrets.

The results shows a little more subtlety when minor/trace elements are analysed. As with major elements (copper and tin), scatter diagrams using arsenic and silver shows that objects which were subsequently inlaid with red glass form a large loose grouping for terrets and bridle-bits (the two most numerous categories) but a much tighter grouping for toggles and horse brooches; (figure 6.28); both groups in which all bronze examples within this hoard are decorated, although the style or manner of decoration varies considerably.

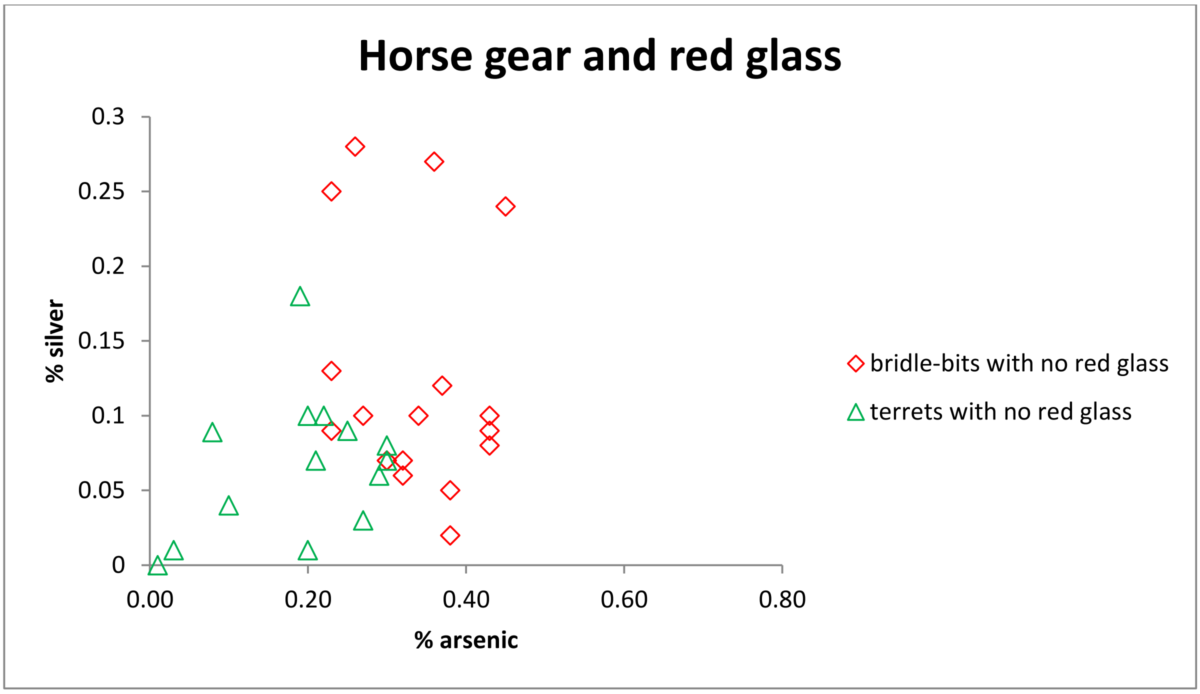


Figure 6. 29: bridle-bits and terrets without decoration

However, although the tin and copper ratios for decorated and undecorated bridle-bits were not particularly distinctive; a pattern does emerge when minor/trace elements are examined. The use of arsenic and silver in figure 6.29 shows a distinction between undecorated bridle-bits and terrets which imply different batches of metal, and thereby the possibility of different workshops for the production of these two types of object. Although this pattern is less clear for the decorated items, there is some grouping of decorated terrets (blue circle in figure 6.28)

This division seems to imply that undecorated objects were cast in episodes by type of object, rather than by the need for future decoration, but that the multiple casting episodes needed for the manufacture of complete bridle-bits obscures the data for this artefact type.

A similar pattern is seen with zinc and lead, the bridle-bit components show the widest range of compositions, but some groupings are still visible (figure 6.30).

Although lead, was routinely added to cast metal objects on the continent and for Romano-British artefacts in the first century AD, it was not generally used for insular La Tène objects. With the exception of one bridle-bit link (46.3-22.64) with an elevated zinc level above 2%; the quantities for both zinc and lead are too small to be deliberate additions, so must be present within the metal source. The majority of the horse pieces form a close group with very little additional lead or zinc.

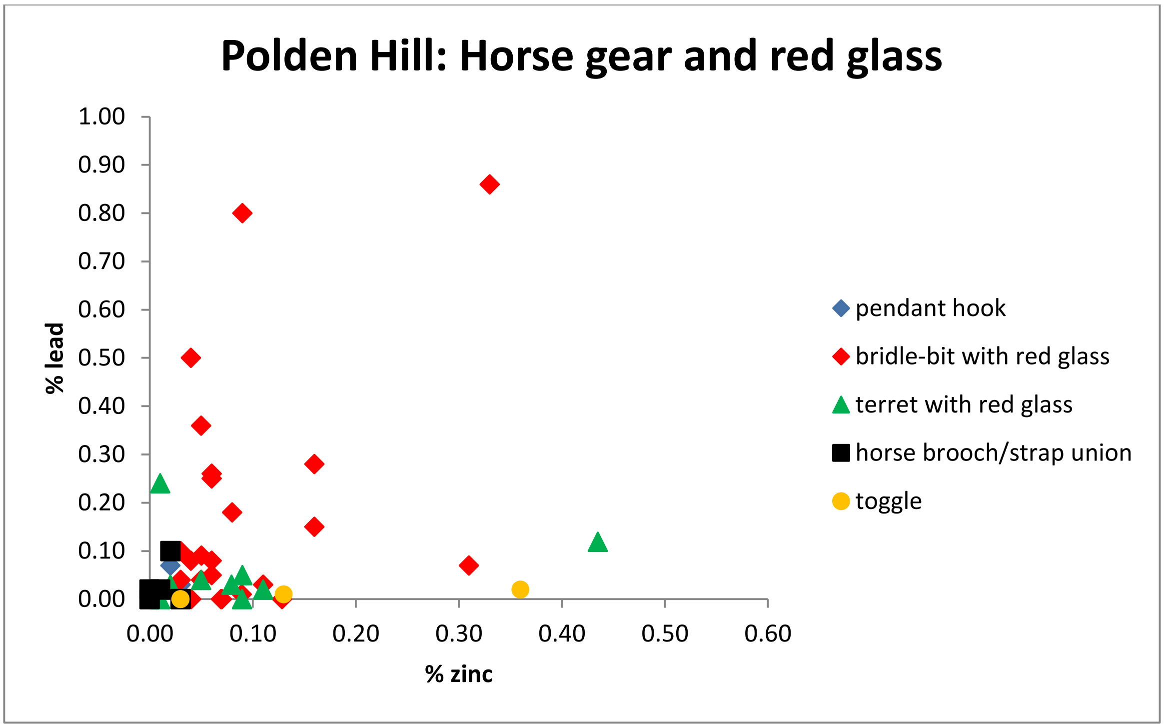


Figure 6. 30: Zinc versus lead levels for horse gear from Polden Hill. The toggles, horse brooches and strap union are tightly grouped; the terrets slightly less so, but there are relatively variable lead levels for the bridle-bit components.

Other decorative traits of horse gear from the hoard

Other decorative features were examined in relation to metal compositions. For both major and minor/trace elements it was difficult to see any distinct grouping for features such as the type of cells used for inlaying glass, or milling decoration which would have been present in the wax prototype (figure 6.31).

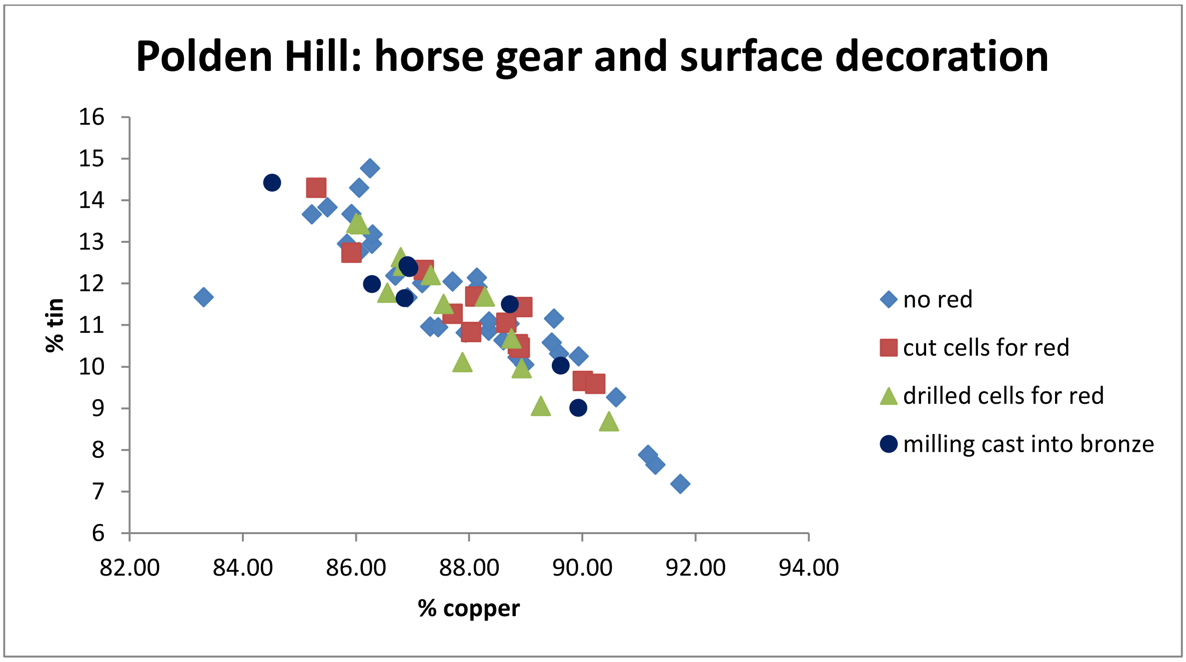


Figure 6. 31: Copper/tin scatter diagram: differently manufactured decorative traits show few clear distinctions between types.

However, the surface appearance or patination of the objects did show some groups when copper and tin were plotted together; the majority of the black patinated and bronze coloured objects form a relatively tight group. As all these objects were buried in one hoard in identical burial conditions, the difference in patination must reflect a difference in surface treatment or use before the objects were buried, (even when taking into consideration post-excavation treatment and conservation).

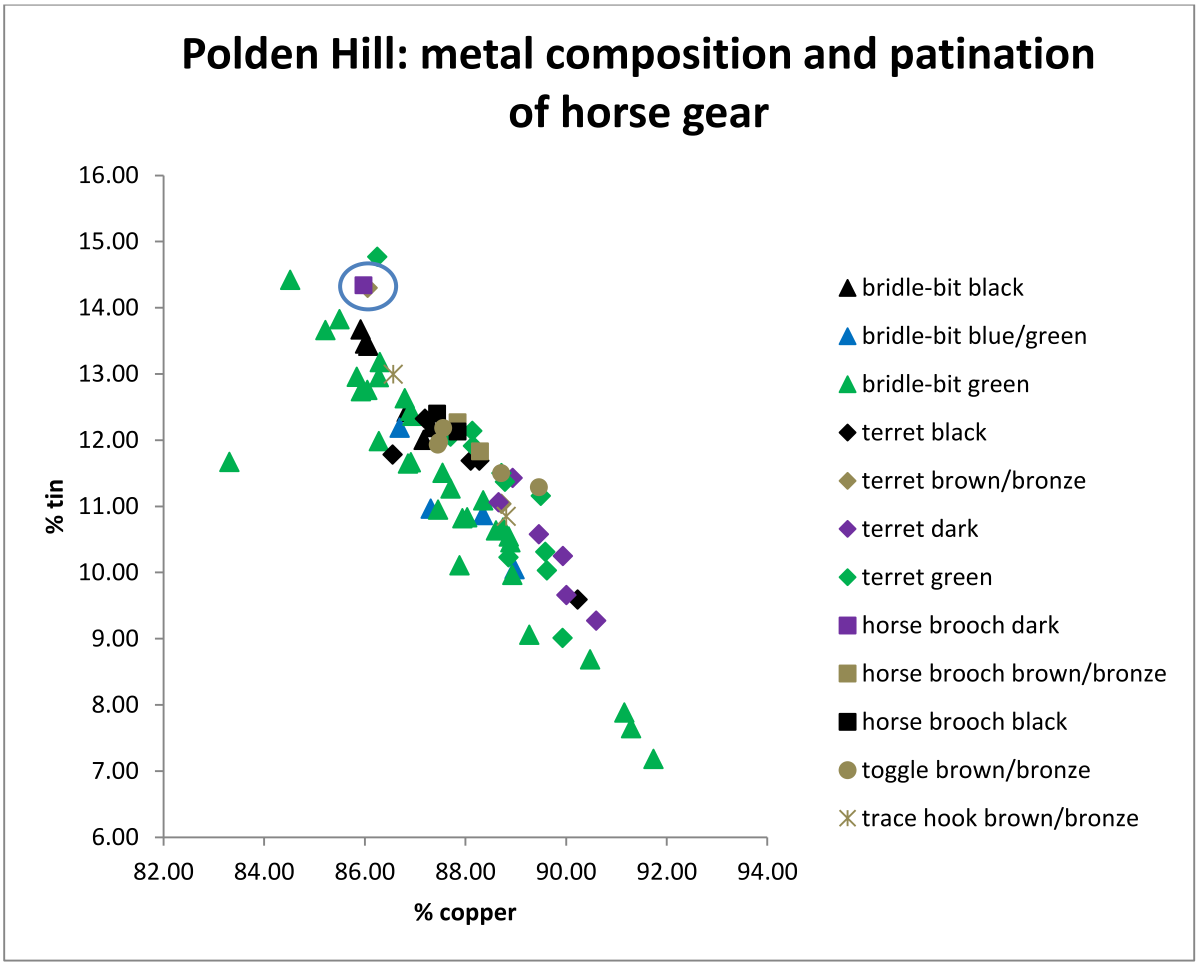


Figure 6. 32: Copper and tin scatter diagram showing different object types and different surface appearances.

The majority of objects with a distinct surface finish tend to group in terms of major element composition; implying a specific finish to objects from specific casting episodes. However, there is again a wider distribution of composition for terrets and bridle-bits which have distinct patinations. This is perhaps not an expected pattern, but importantly could imply that on occasion decoration was not necessarily pre-planned but sometimes, at least, applied to these categories of objects after their dispersal from the metalworker, and perhaps at the instigation of the 'owner'. Interestingly, the exception for the horse brooches in terms of appearance (shown in the blue circle in the diagram above), is the upper part of the large two piece horse brooch (46.3-22.112), which also contains the only sampled piece of 'Roman' style red glass in the hoard.

Observation has shown that decoration certainly occurred on some objects after the application of the black patination had been applied (figure 6.33), and this could imply a distance in time/space/ownership before different craftsmen applied their surface finishes.

Figure 6. 33: Detail from 46.3-22.95, showing lines cast in on one terret lip (left) and scribed in after casting on another (right).

The two terret lips illustrated in figure 6.33 give some indication of a usual sequence of decoration. The moulded edge decoration and the cast in lines are predominantly black; the post-casting scribed lines are not. This would mean an order of *pre-decoration on prototype → cast → patinated → scribed.*

Bridle-bit pairs and sets

Although terrets form the largest number of objects, the largest number of analyses was carried out on the bridle-bits. As each complete bit had four components and incomplete bits at least one, this gave a relatively large amount of data, and enabled links between the components to be examined. All the bridle-bits in this hoard are two-link bits and would have to have been cast in three separate episodes. One likely scenario is that the rings were cast first; then one link was cast onto an extant ring; the next link would then be cast onto the newly cast link and the second ring. If this is the case, the rings are the most straightforward part of each bit, and could be made in advance, or even a stock of rings maintained by the bronze smith, who potentially could include reclaimed rings from broken or miscast pieces. By contrast, the links would be cast *in situ* onto adjacent, pre-cast components. Examination of separate components could give an indication of how such casting was organised.

Many of the bridle-bits within the Polden Hill Hoard appear to be 'matched pairs'; this is evident by decorative components, the style of the link pieces, and similar surviving patination.

The possible pairs are described and illustrated below:

Figure 6. 34: Bridle-bits 46.3-22.65 and 46.3-22.71.

The two bits 6.34: Bridle-bits 46.3-22.65 and 46.3-22.71 (figure 6.34) are very similar in form, both with ‘septagonal ‘side-links (Palk 1984, 14), however, their patination is dissimilar. A further difference is that 46.3-22.71 has a pelta shaped inlay of red glass, whereas 46.3-22.65 does not. Interestingly, 46.3-22.75 has similar decoration to 46.3-22.71, cut into the lobe of the side-link after casting. This questions whether 46.3-22.65 and 46.3-22.71 were originally cast as a pair, but subsequently treated very differently: the copper v zinc scatter diagram (figure 6.46) shows they have similar metallurgical compositions.

Figure 6. 35: Bridle-bits 46.3-22.66 and 46.3-22.67.

Bridle-bits 46.3-22.66 and 46.3-22.67 (figure 6.35) have finely cast stitch-like decoration, with sub-rectangular side-links but no glass inlay. This pair has a fine bluish green surface patina.

Figure 6. 36: Bridle-bits 46.3-22.64 and 46.3-22.73.

Bridle-bits 46.3-22.64 and 46.3-22.73 (figure 6.36) are undecorated, but have ‘winged’ side-links (Palk 1984, 14).

Figure 6. 37: Bridle-bits 46.3-22.72 and 46.3-22.74.

The bridle-bits pair 46.3-22.72 and 46.3-22.74 (figure 6.37) have cast in ladder decoration on the wings of the side links, and an extremely fine bluish green patination. As with the pair 46.3-22.66 and 46.3-22.67 above, they have sub-rectangular side-links but no glass inlay, and in many respects appear very similar.

Figure 6. 38: Bridle-bits 46.3-22.68 and 46.3-22.69.

The Bridle-bits 46.3-22.68 and 46.3-22.69 (figure 6.38) are the most highly decorated pair; both bits have drilled recesses for red glass of identical composition (see below), inscribed pelta-shaped lines filled with small dots, and a shiny black patination.

Figure 6. 39: Bridle-bits 50 46.3-22.77 and 46.3-22.78/79/80.

Both bridle-bits from the pair 50 46.3-22.77 and 46.3-22.78/79/80 (figure 6.93) have been broken across their side-links, and the majority of 46.3-22.77 is missing. They have drilled recesses for red glass, none of which survives, a similar green patina and notched side-links.

Figure 6. 40: Bridle-bits 46.3-22.70 and 46.3-22.76.

The bridle-bits 46.3-22.70 and 46.3-22.76 (figure 6.40) had drilled holes for glass inlays, winged side-links and an even green patina for the rings. However, the links for 46.3-22.76 are in a very different condition and heavily encrusted with corrosion. Interestingly the red glass from this component (table 3; figure 6.70), is very similar in composition to that on the heavily corroded bridle-bit 46.3-22.75 (figure 6.41; 6.42).

Figure 6. 41: Bridle-bit 46.3-22.75 (presumably paired with example in Bristol Museum E.1785) and ring 46.3-22.81.

Bridle-bit 46.3-22.75 (figure 6.41) is described by Brailsford (1975, 227) as having ‘enamel decoration on outer end of each link’. In this respect the decoration is similar to 46.3-22.71. There is also a single ring: 46.3-22.81, which Brailsford thinks might be paired with 46.3-22.76 (Brailsford 1975, 224).

Figure 6. 42: Pelta-shaped cut and inlaid recesses on bridle-bits 46.3-22.71 and 46.3-22.75 (obscured by corrosion products). Both are similarly cut and shaped; it could be argued that they contain similar glass compositions (depending on how the degree of the separations of group 1 and 2 are interpreted), but are from different pairs.

The major element pattern for the analysed components of the bridle-bits offers a complex picture. Some components from separate pairs show a degree of ‘grouping’, as with 46.3-22.65 and 46.3-22.71 (figure 6.43 red symbols); this becomes clearer when bridle-bit pairs which contain (or used to contain) red glass are shown separately (figure 6.44).

Silver and arsenic values show more obvious groups for bridle-pair sets; there is some ‘mix’ which is understandable considering the complex series of casting operations needed to complete a whole bit; but this does imply that bronze smiths were making the objects as pairs, but that different batches of bronze were being used (figure 6.45).

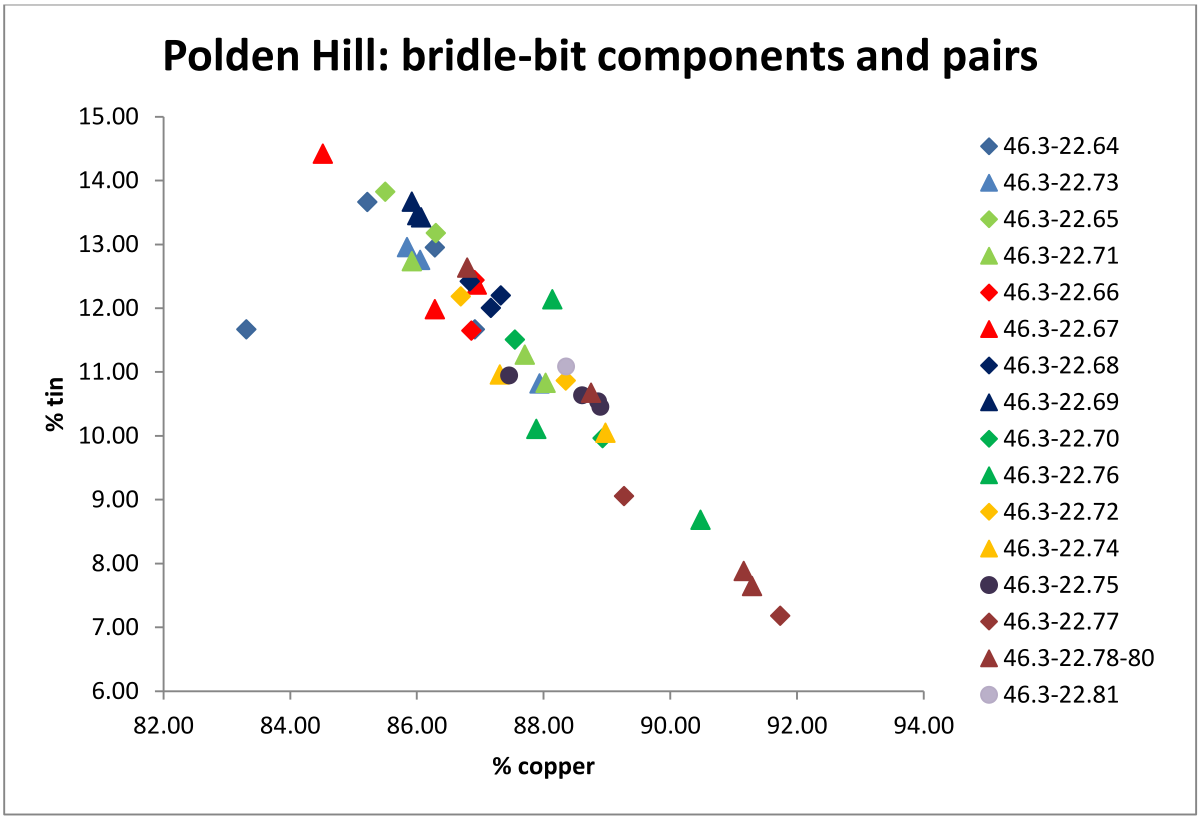


Figure 6. 43: The gunmetal outlier, a link from 46.3-22.64, can be seen quite clearly; all the other components show a tin/copper correlation for their composition. Each pair is denoted by the same colour, but using separate symbols.

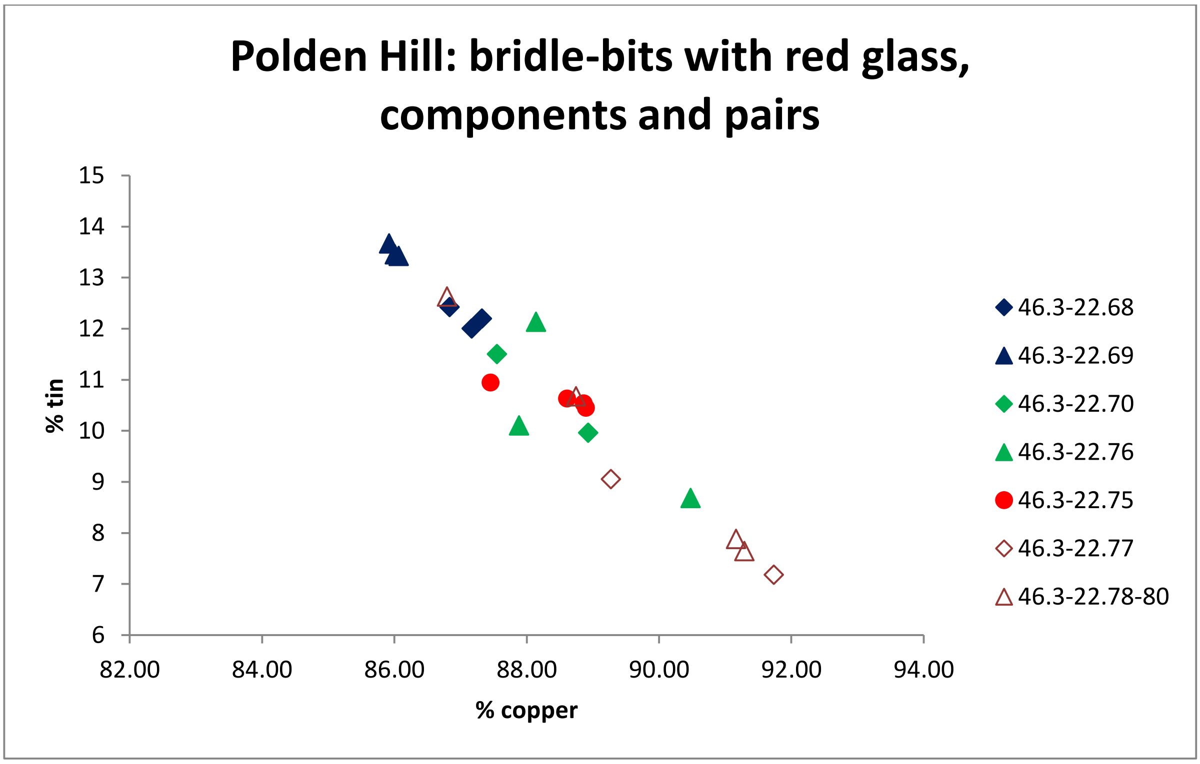


Figure 6. 44: copper tin scatter diagram showing bridle-bit pairs which contain (or did contain) red glass

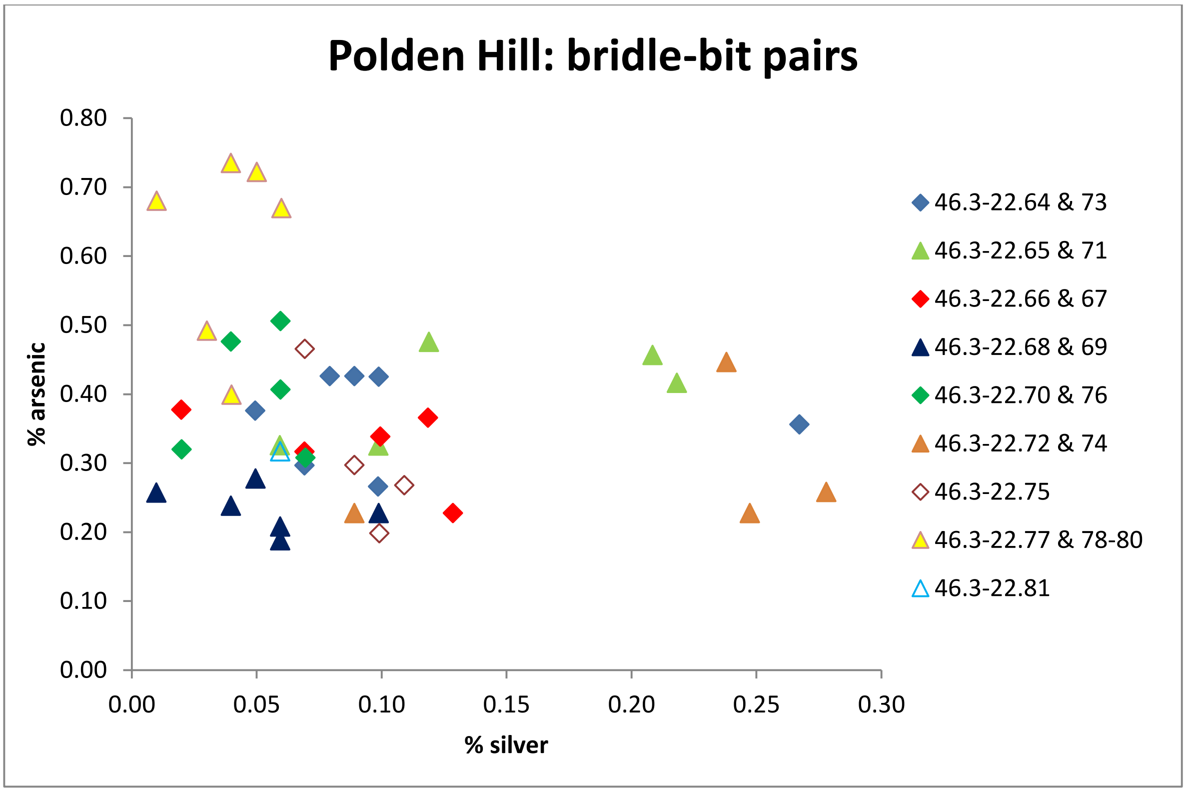


Figure 6. 45: Scatter diagram of silver and arsenic showing bridle-bit pairs.

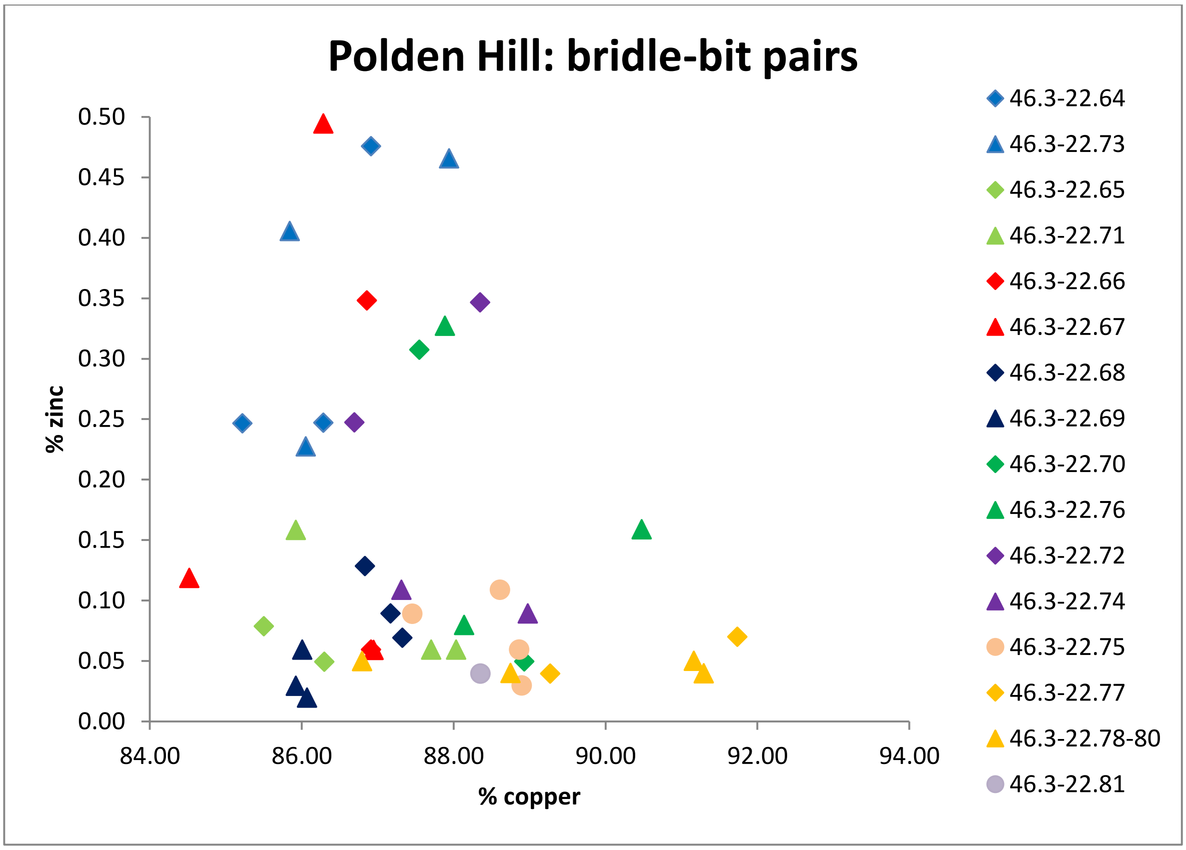


Figure 6. 46: Scatter plot of copper and zinc content of all bridle-bit components analysed; each pair is denoted by the same colour, but has separate symbols for each bridle-bit.

There is some correlation between single bits and pairs in the scatter diagram for copper and zinc, although here groups of components from the same pair are often compositionally closer than components from the same individual bit. Again, this might be expected, as each bit required several steps in its manufacture, and different 'melts' would be used for the manufacture of different components; the general implication is again, that the bits were manufactured in pairs.

Further elemental analysis using copper, tin and zinc (figure 6.47) seems to show some distinction between the metal composition of pairs containing red glass, and those which do not.

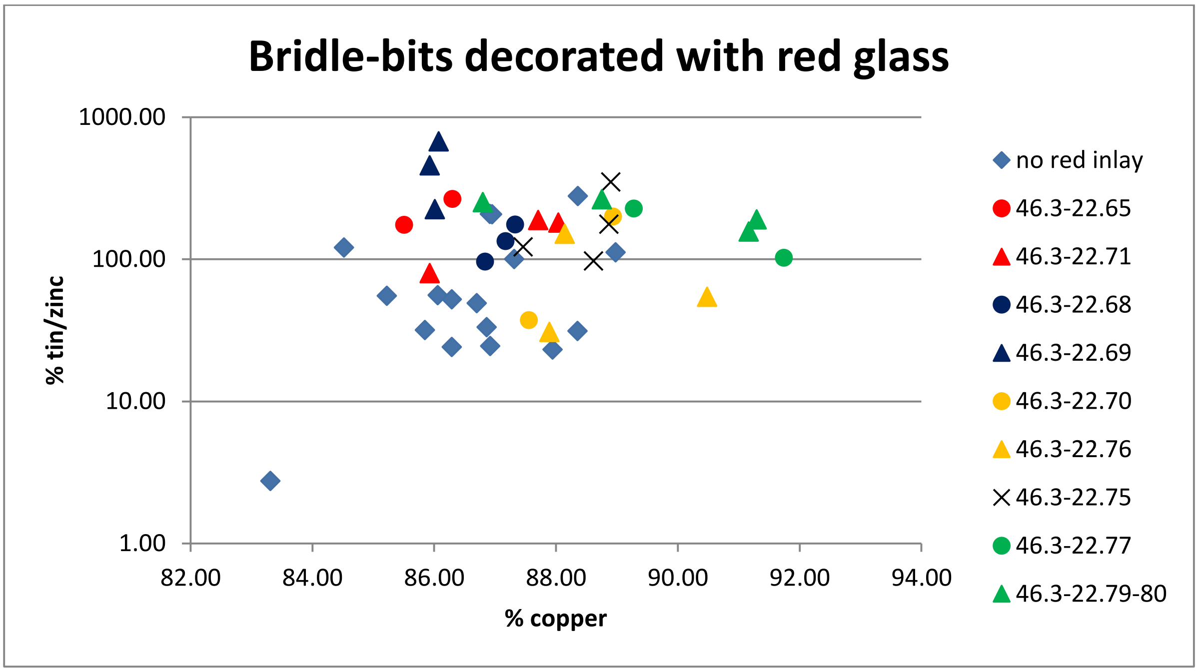


Figure 6. 47: Analysed bridle-bit components (rings and links), showing which objects are decorated with inlaid red glass. Decorated pairs are shown using the same colour but different symbols.

Figure 6.47 shows a visible, though not complete distinction, by metal composition between bridle-bits with and without red glass inlays; the tin/zinc ratio is consistently higher for the former group. The main exceptions, seen in the lower half of the graph are 'link' components belonging to the pair 45.3-22.70/76 (yellow symbols). The non-inlaid bridle-bit components in the upper half of the scatter diagram come from the single ring (45.3-22.81), and two bits with ladder decoration on the link 'wings' but no red glass (45.3-22.67 and 45.3-22.74).

No distinction could be found between rings and links within the same pairs when using different elements (figure 6.48); some show a strong overlap, others some separation, but this is not always consistent between different elements.

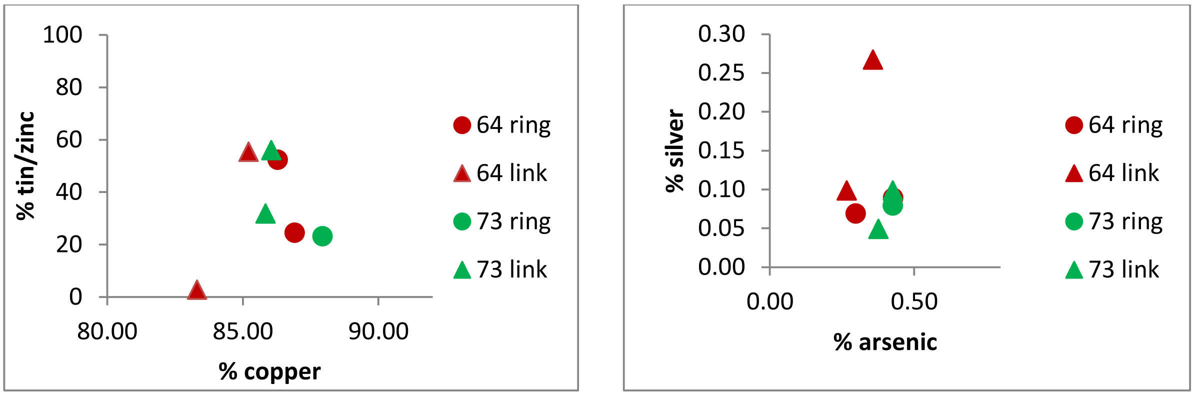


Figure 6. 48: Two scatter diagrams showing different analysed components from the bridle-bit pair 45.3-22.64/73.

Detailed analysis of the bridle-bit components is interesting as it can look at individual parts, how these are distributed within whole bits, and how pairs of bits relate. The results are complex, but compositional differences can be discerned along with a general picture which implies pairs were manufactured at the same time, with different casting episodes, but on the whole using bronze of very similar composition. This is also verified by the composition of the red glass, which where extant, is similar within pairs. The rogue gunmetal link could have been a later replacement for a broken or failed cast; it is significantly different from all other metal compositions in the hoard.

Bridle-bits and patination

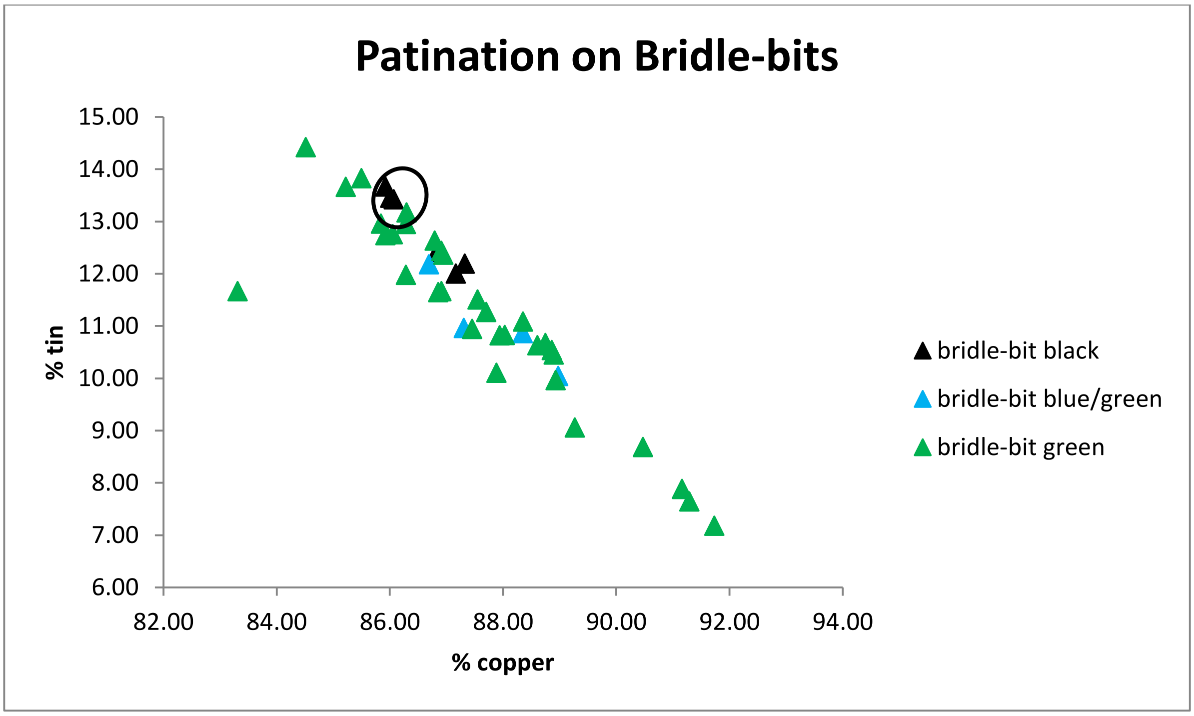


Figure 6. 49: Scatter diagram using copper and tin showing colours of patination on the bridle-bits.

As with the horse gear as a whole (figure 6.32), pairs showing distinct patinations are mostly grouped together. The three circled analysed components from the black patinated bit 46.3-22.69 (figure 6.38) are probably from a different casting episode to the three black triangles containing less tin (from its pair 46.3-22.68). The blue green patinated components, 46.3-22.72 and 46.3-22.74

(figure 6.37) all form a larger group. Similarly formed and decorated cast pairs were set aside for similar applied surface treatment.

Terrets: single items and sets

There are fifteen terrets from the hoard, and this forms the largest category of items. Brailsford catalogued them by type, but also noted where ones were nearly identical, and therefore might be regarded as part of a set. Using Brailsford's work (1975, 223-224), the terrets can be divided as follows:

Terret number	Type	Grp	Form	Decoration
46.3-22.82/83/85	Type 1	1a	Flat bar, plain hoop	milling
46.3-22.84/86/87	Type 1	1b	Flat bar, plain hoop	none
46.3-22.144	Type 1	1c	Flat bar, plain hoop	none
46.3-22.88/90/91/102	Type 2	2a	longitudinal lips	Red glass
46.3-22.89/101/103/104	Type 2	2b	longitudinal lips	none
46.3-22.94	Type 2	2c	longitudinal lips	Dot-filled peltae, red glass, black
46.3-22.95	Type 2	2d	longitudinal lips	Red glass, black
46.3-22.96	Type 2	2e	longitudinal lips	Red glass, black
46.3-22.97	Type 2	2f	longitudinal lips	none
46.3-22.98	Type 2	2g	longitudinal lips	Dot-filled peltae, red glass, black
46.3-22.93	Type 2	2h	longitudinal lips	none
46.3-22.99	Type 2	2h	longitudinal lips	none
46.3-22.92	Type 3	3a	transverse lips	none
46.3-22.100	Type 3	3b	transverse lips	Red glass, incised lines

Table 6. 2: Terret types, sets and decoration.

Brailsford (1975, 223-224) classified the terrets into three types: 1 has plain hoops; 2 has longitudinal lips and 3 has transverse lips. He groups these further into sets of similarly formed terrets, although not all his sets are convincing. There are four definite 'sets', where more than two terrets are very similar in appearance, weight and dimensions. However Brailsford (1975, 224) also classifies two further pairs as 'sets': 46.3-22.93 and 46.3-22.99 (figure 6.50) and 46.3-22.82 and 46.3-22.85. These pairs have significant differences in shape and size, so are not used as 'sets' in the analysis below.

Figure 6. 50: Terrets 46.3-22.93 and 46.3-22.99.

Figure 6. 51: Terret set of three: Group 1a: 46.3-22.85; 46.3-22.82, (46.3-22.83 not photographed).

Figure 6. 52: Terret set of three: Group 1b: 46.3-22.84; 46.3-22.87 and 46.3-22.86

Figure 6. 53: Terret set of four: Group 2a: 46.3-22.88 (not photographed), 46.3-22.90; 46.3-22.91; 46.3-22.102.

The terrets from Group 2a (figure 6.53) appear almost identical. However, six samples of glass were taken from the four objects; one each from 46.3-22.90 and 46.3-22.102; and two each from 46.3-22.88 and 46.3-22.91. Analysis of the glass shows that this came from two different element 'groups' (figure 6.70; table 6.3) with one of the samples from 46.3-22.91 and the sample from 46.3-22.102 in group three, along with glass from several other objects, including two further individual terrets, two horse brooches and a bridle-bit pair. The remaining analysed glass from this set made up the distinct fourth group. There is no straight forward explanation as to why two compositions of red glass were used; but the decoration on terrets from this set do appear to have been cut into the metal after casting, and as a later embellishment (figure 6.76; 2.89); this may not have been done by the original metal smith, but on a later occasion by someone who had access to traded ingots or pieces of glass.

Figure 6. 54: Terret set of four: Group 2b: 46.3-22.89; 46.3-22.101; 46.3-22.103 (46.3-22.104 not photographed)

The terrets within groups show some similarity to one another in major element composition, the exception being one terret from group 1b: 46.3-22.84 (figure 6.52). This overall similarity could imply one casting episode, or one bronze-smith concentrating on making sets.

Scatter diagrams using minor elements show some similar patterns, but here one from each group seems slightly different in composition. This could represent one terret being cast initially, and the rest of the group cast later, using the initial terret as a pattern or former. In this way, different casting episodes, as with the bridle-bit components, may be discerned (figure 6.55).

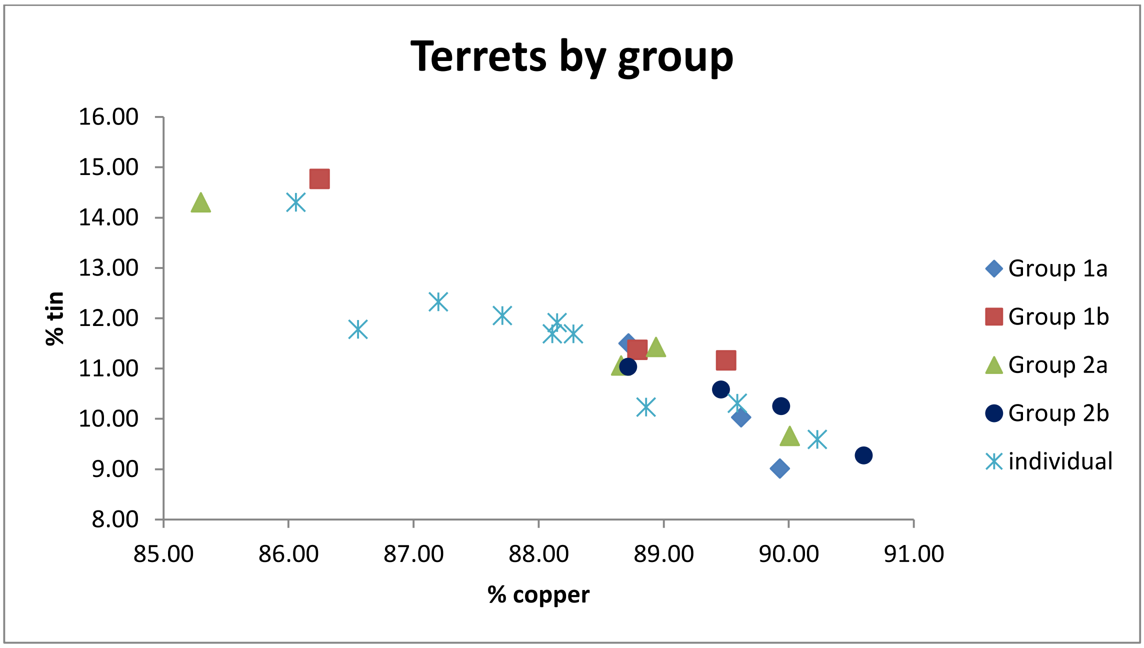


Figure 6. 55: Copper and tin scatter diagram showing a concentration of terret sets are made using relatively high copper to tin ratios in their bronze.

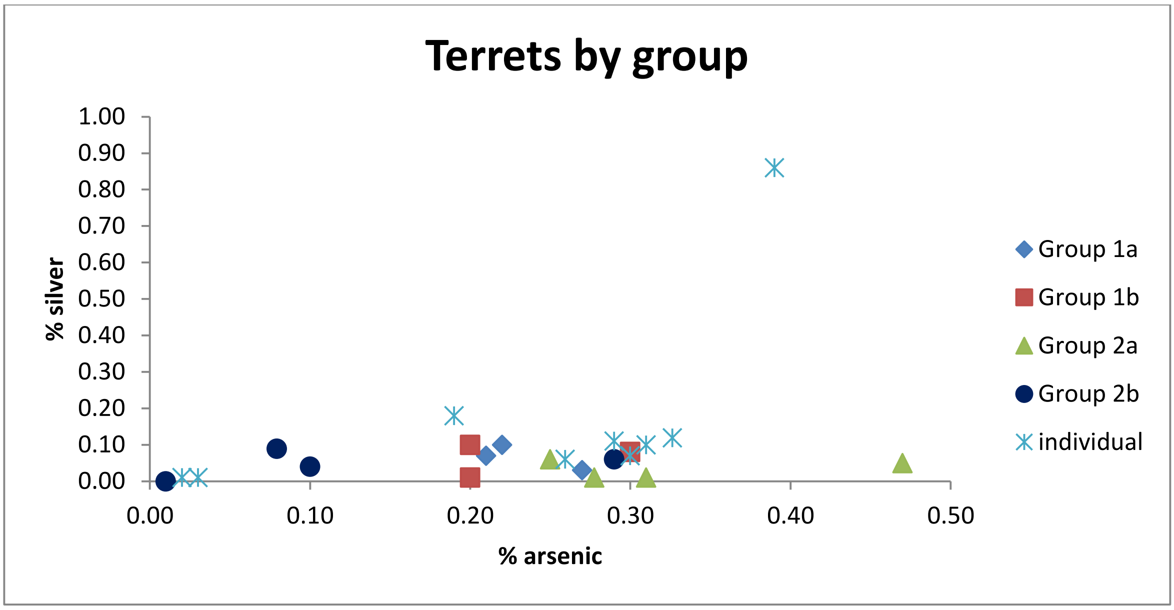


Figure 6. 56: Scatter diagram of arsenic versus silver content. Most groups show one terret as slightly distinct in composition.

Terret decoration

Many of the terrets are decorated in one way or other, five in particular are large single objects (46.3-22.94; 95; 96; 98; 100) (figure 6.60; 6.61), which might be regarded as the central elaborate item in a set of five (appendix 9).

The decorated terrets appear to mostly have similar arsenic and silver values (figure 6.57). Similarities between features can be seen with the type of decoration (figure 6.57) and type of patination (figure 6.58; 6.59). Unlike the bridle-bit sets, there is some correlation in minor element composition and applied decoration.

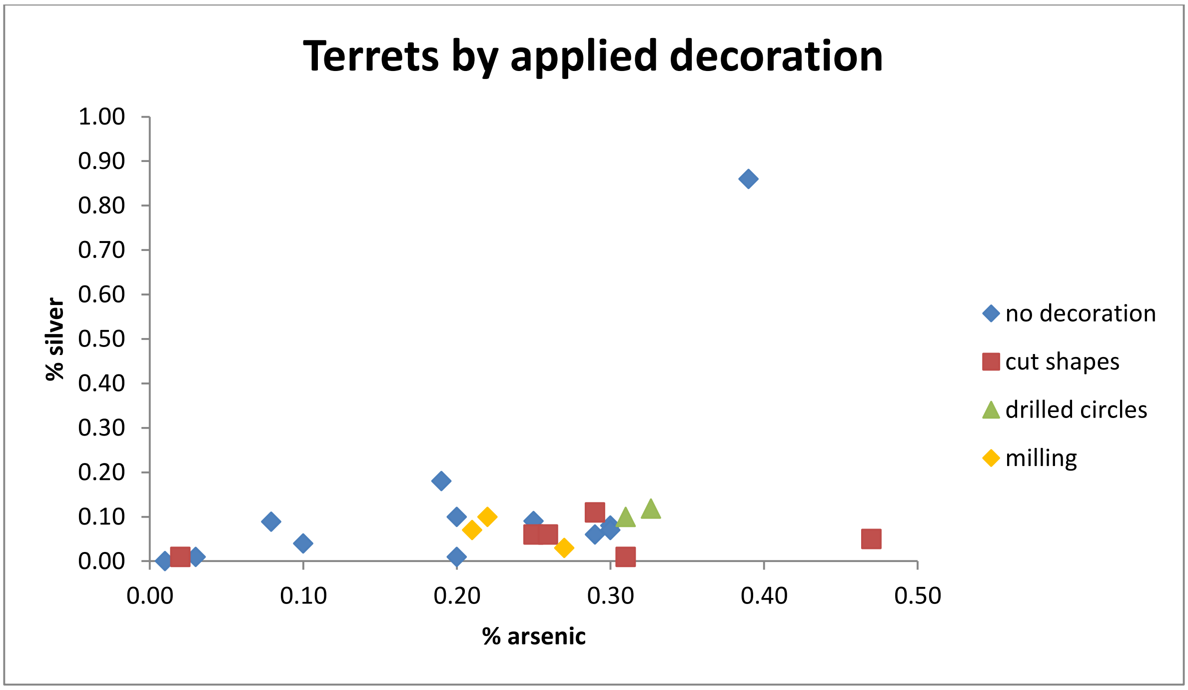


Figure 6. 57: Decorative techniques applied to terrets.

Terret patination

Assessing terrets by their surface patination also shows some grouping.

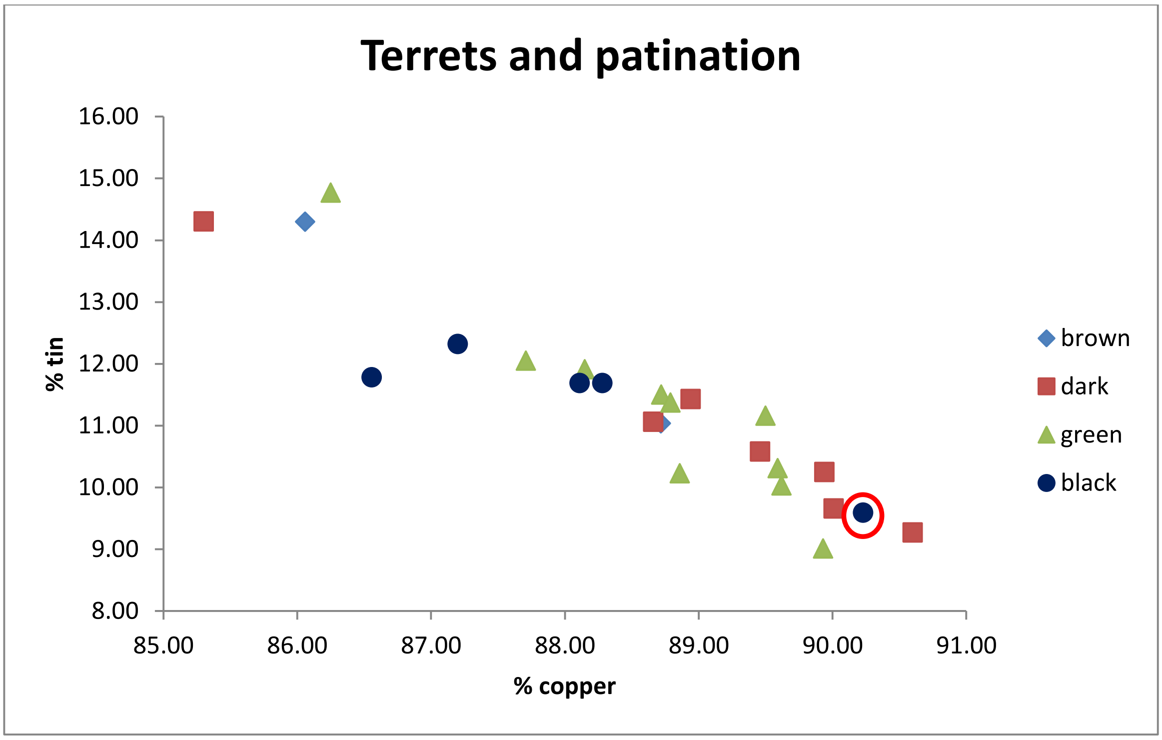


Figure 6. 58: Distribution of patination types on terrets when using major element compositions (The circled blue dot is 46.3-22.100).

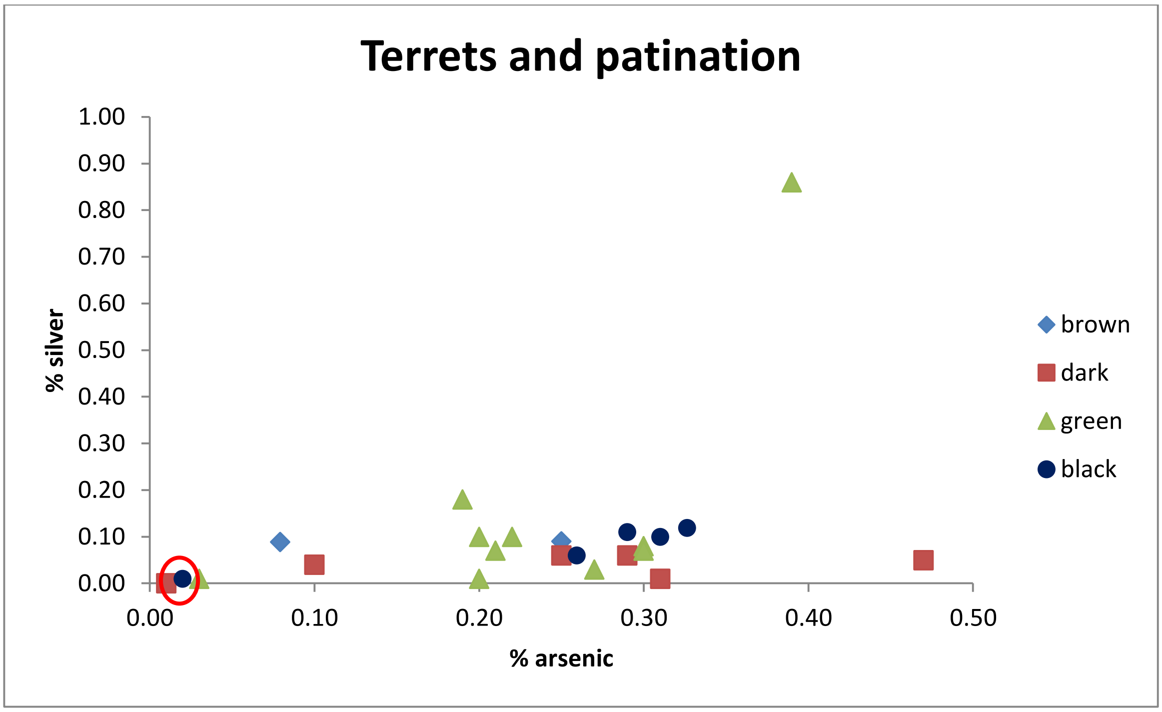


Figure 6. 59: Grouping by patination visible on terrets using minor/trace element composition. (The circled blue dot is 46.3-22.100).

Terrets that form groups of two or more similar items tend to be patinated with a dark or a green surface. The distinct black patination seems to be reserved for individual objects, and many of these have a similar metallurgical composition (figure 6.59). The four large black terrets 46.3-22.94-96 and 46.3-22.98 (figure 6.60) all have individual decoration, but also have features in common: they are all relatively large, have red glass inlays and a 'saddle bar' for attachment. The use of saddle bars on large terrets is also seen in the Middlebie hoard (chapter 9), and could indicate slightly different use, for example as the central terret of a set rather than an outer rein ring. The overall similarity of these four examples from Polden Hill implies a link between those casting the objects and their subsequent life history. They were all patinated in a similar manner, they were subsequently possibly kept together or used throughout their life in connected places or as a group, and were finally deposited together in the hoard.

The burial conditions are unlikely to have affected their final appearance to a large degree; as stated earlier, the burial conditions, as far as we know, were all the same; (green is the vaguest category here and might cover several different terret 'lives').

The most distinct terret 46.3-22.100 (figure 6.61; 6.76; 6.78 and shown in red circles on figure 6.58; 6.59) combines more decorative features than all the others, using scribed lines and incised shapes for red glass; it is one of only two terrets with transverse lips; it also has a black patina. The black patina has a slightly duller quality than the other black terrets, and this object may well have been patinated on a separate occasion, or by a different manufacturer, which is a further way in which this object stands out. It is also the only terret to contain 'Group 1' glass. Other objects from this group include the heavily corroded and encrusted links from the bridle-bits 46.3-22.75 and 46.3-22.76 (figure 6.40; 6.41), both of which are broken and incomplete (they are not a pair, and the underlying patination cannot be determined); the toggle which was possibly originally blackened but now appears largely bronze (figure 6.65), and the strap union which is in very similar condition (figure 6.62). This forms an interesting group in terms of surface decoration, both by surface appearance and red glass inset; however, metallurgically there is less consistency in their compositions (figure 6.25). There is evidence that the toggle and strap union also originally had a black patinated surface, and it is also possible that they were originally heavily encrusted when found but have since been chemically stripped or cleaned. The terret 46.3-22.100 does show some signs it formerly had some green encrustation, and appears to have been conserved mechanically, only removing outer dirt and corrosion. It could be that the history of the objects within the British Museum has altered their surface appearance, which might have been similar at their point of deposition (figure 6.94); it is possible all these objects were once similarly patinated.

Figure 6. 60: Large individually decorated terrets with black patinated surfaces 46.3-22.94-96 and 46.3-22.98.

Figure 6. 61: Terret 46.3-22.100 plus detail of decoration.

Horse Brooches/Strap Union

The horse brooches are very similar to one another in terms of metal composition, but the red glass inlays come from separate groups, (apart from the top half of 46.3-22.112/113) and 89.7-6.79; which are both from glass group 3 (figure 6.70; table 3). Only the strap union 89.7-6.77 out of these large highly decorated pieces does not have a black upper surface, but as argued above, this is possibly due to modern surface treatments. All the horse brooches and the strap union form a set of objects with large complex two dimensional surface patterns created by cast metal, voids and red glass;

scribed and cast lines are also used on all the horse brooches, but not the strap union. The backs of the objects are all slightly rough with relatively little care taken over the finish but the reverse would not normally have been visible (similarly cast strap unions and junctions with 'unfinished' backs are also quite common in the Middlebie Hoard (chapter 9)).

As has been mentioned, the large two piece brooch (46.3-22.112-113) is unusual in having slightly more 'geometrical' design motifs (figure 6.80) (angles as well as curves). One half of the pieces (46.3-22.112) also has higher tin levels than all the other horse brooch pieces (figure 6.64), and one of the two samples of the inlaid glass from the larger part of this object (46.3-22.112) is of a distinctly different 'Roman' composition (chapter 5) (figure 6.70; table 3). It is impossible to know the explanation for this, but there are possible options. The person inlaying the glass had supplies of sealing wax glass, but also had traded and acquired 'Roman' style red glass as this became more readily available; or this piece could have been further embellished or repaired after its original manufacture. The Roman style red glass would probably have looked distinctly less bright when newly polished.

Figure 6. 62: Strap union 89,7-6,77: the suggestion is that that 77 and 143 (See figure 6.63 below) were originally black but have been extensively 'conserved' or cleaned.

Toggles

There are five bronze and two iron toggles in this hoard, and they form an interesting group. Toggles are often found as single items as with those from Newport (PAS A435B8) and Felin Frach (PAS NMW-2362B2); single toggles have also been found with other horse related materials, as with the example from Maescar found with a bell (Gwilt and Lodwick accessed 2014).

The toggles here could be argued to belong to three pairs; two similar plain examples of iron, and four similarly decorated bronze objects. The fifth bronze toggle is single and distinctly different.

Figure 6. 63: Three of the four similar toggles from the hoard 46.3-22.136; 142 and 137-8.

For the four similar items the decoration is complex, symmetrical and directly repeated on all four objects. They all once contained red glass, but this has now completely degraded in all except one example, and the patina is slightly, but not significantly different on each piece. Whether this means they were originally cast as a set and then used separately is impossible to say. Metallurgically, they are relatively similar.

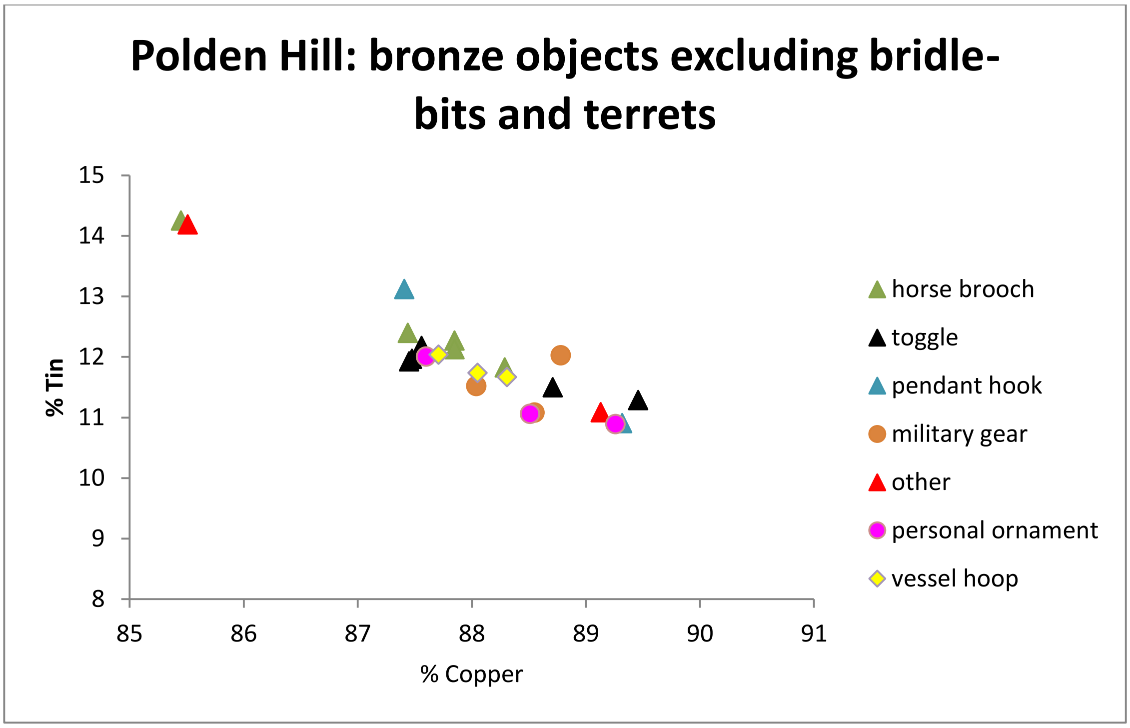


Figure 6. 64: copper versus tin content of bronze objects other than terrets and bridle bits within the hoard The two pieces with high tin are the larger half of the horse brooch 46.3-22.112 and the hammer 46.3-22.133.

Figure 6. 65: The distinct toggle 46.3-22.143; this has a similar patination to the strap union 89.7-6.77 (figure 6.62).

The composition and use of red glass on the horse equipment

As discussed, much of the horse equipment contains red glass. This is missing from several objects, and is very degraded in others. Where possible the red glass was sampled from all the relevant objects.

The objects containing red glass are as follows:

- Sixteen bridle-bits, of which six out of nine still contain some red inlay suitable for sampling, and one is in Bristol.
- Three horse brooches, all of which still contain some red inlay suitable for sampling.
- One strap union, which still contains some red inlay suitable for sampling.
- Twenty-four terrets, of which nine out of nine still contain some red inlay suitable for sampling.
- Eight toggles, of which two out of six still contain some red inlay suitable for sampling, and two are of undecorated iron.

Some objects were sampled more than once, especially where different styles of inlaying were present, and where the glass was suitable for sampling. Altogether thirty-four samples were taken (Table 3).

Figure 6. 66: Bridle-bit (46.3-22.68) showing predominantly degraded powdery green glass with small extant areas of better preserved red glass with small areas of red glass surviving.

Elemental composition of the red glass

Almost all the glass from Polden Hill is of the 'sealing wax' red type (chapter 5) and the results of elemental analyses of the samples show a high level of consistency with one another and correspond well to other opaque red glasses from Britain (figure 6.68) . There is one perpetual outlier: one of the sampled areas from the upper part of a two piece horse brooch 46.3-22.112 (figure 6.67) which is different both in its elemental composition and in its micro-structure; it is the only sample where cuprite dendrites are not visible under either an optical or scanning electron microscope. As noted previously, this particular artefact was also slightly unusual stylistically, containing geometric shapes as well as circular punch marks (figure 6.80).

Figure 6. 67: Horse brooch (46.3-22.112/113). The perpetual outlier in the scatter diagrams below comes from the upper (left hand) part of this artefact.

One way in which elemental data for sealing wax red glasses has been analysed in the past is by plotting copper oxide levels against lead oxide levels (Hughes 1972; Henderson 1989) (figure; 6.68).

It can be seen from figure 6.68, that there is one outlier; this is from the larger part of the horse brooch 46.3-22.112, this glass has a composition similar to Roman tesserae (chapter 5: figure 5.20) rather than the sealing wax red glass used for the rest of the hoard.

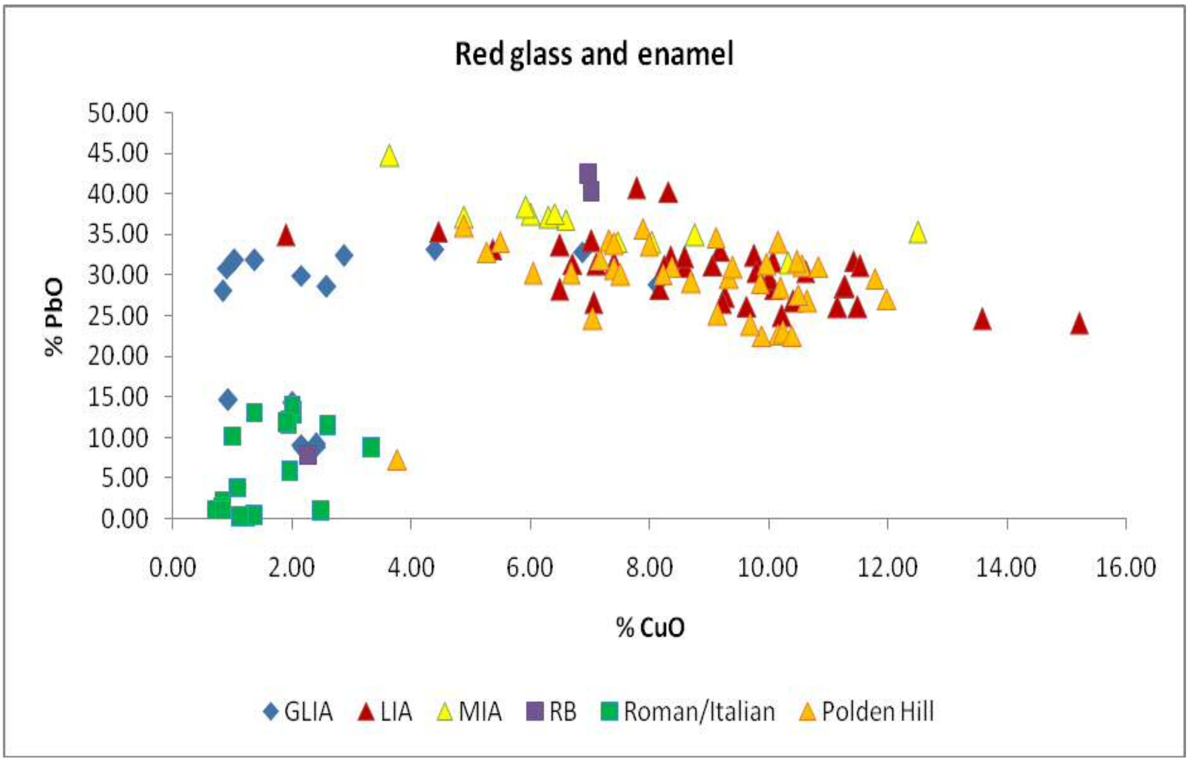


Figure 6. 68: Iron Age and Roman red glass and enamel from Britain and Italy. Copper oxide levels plotted against lead oxide help place the 'Roman' glass as a distinct type compared to that from the Iron Age.

Figure 6.68 also shows how closely analyses from Polden Hill compare to other analyses of similar types of Iron Age sealing wax red glass.

Further elements can be plotted to detect more subtle differences within the Polden Hill material. Three elements when plotted together which give a degree of separation are manganese and magnesium/potassium (figure 6.69; 6.70). These all occur naturally within the raw glass materials to some extent, but elevated levels can suggest deliberate addition for various reasons.

The levels of Manganese oxide within the Polden Hill hoard vary from 0.02-0.66%. Manganese oxide is a common impurity in both sand and ash. However, levels above 0.2% could well indicate its deliberate addition as a decolourant in Iron Age/Roman glass (Freestone pers. comm.). The higher levels seen in a number of the glass samples from a group of terrets from the hoard could imply a later date, certainly a different batch of glass, and possibly a different recipe for these glasses.

Levels of magnesium oxide divided by potassium oxide levels introduce two further compounds. Magnesium and potassium oxides show a noted consistency in soda lime silica glasses, where a potash/Magnesia correlation is largely maintained (Bateson and Hedges 1975, 181). First and second century BC soda-lime-silica glasses commonly contain c. 0.5% potash (Henderson 1988); the potash levels in all the Polden Hill samples of glass (except for the outlying horse brooch 46.3-22.112), range from 0.16-0.7%. The horse brooch (46.3-22.112) shows exceptionally elevated levels at 3.75%.

Magnesia levels in the Polden Hill glasses range from 0.26-0.59%; the horse brooch also has elevated levels here of 1.45%.

Freestone and Stapleton (2015) believe that the elevated levels of potash and magnesia could be as a result of adding furnace ash to the glass. The ash would contain carbon which would act as a good internal reducing agent within the glass matrix, helping to obtain a red colour from copper, but leaving higher traces of potassium and magnesium oxide within the glass.

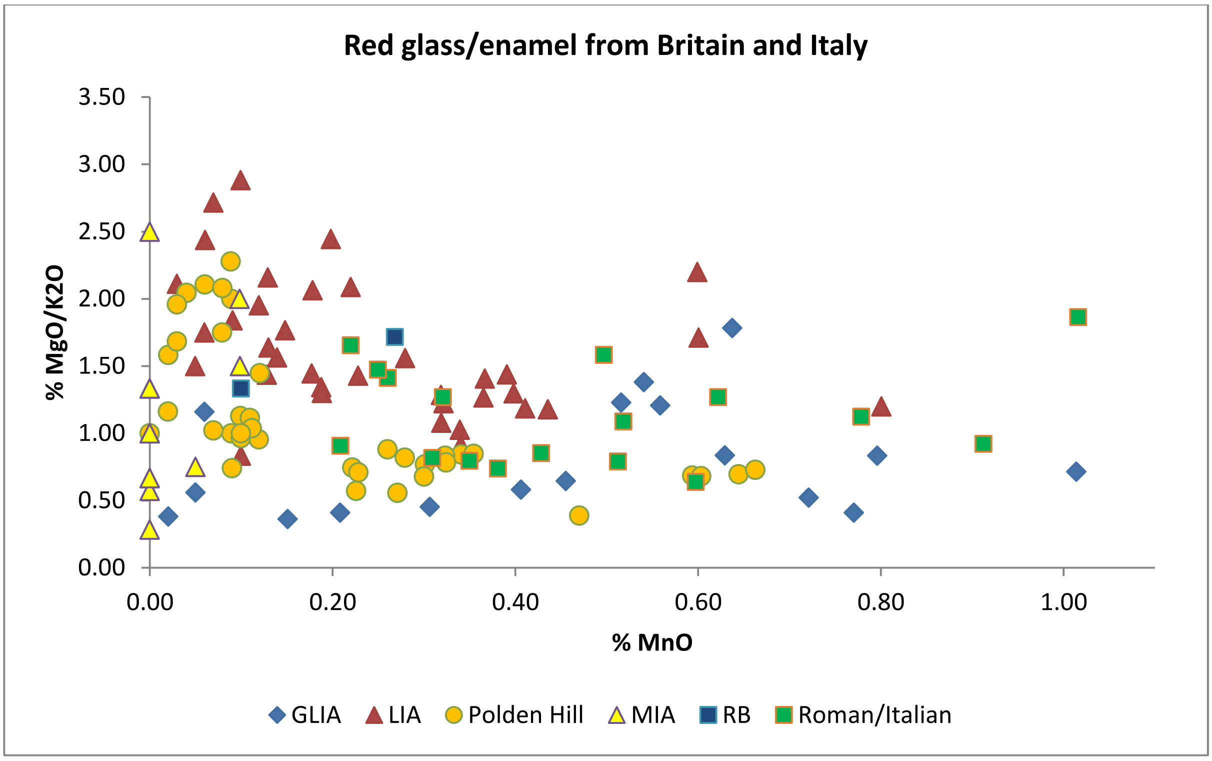


Figure 6. 69: Manganese oxide levels versus potash over magnesia for British Iron Age and Roman red glass. The outlier (46.3-22.112b) corresponds more to the Roman/Italian red glasses with its elevated potassium oxide and magnesium oxide levels. It also compares well with geometric Late Iron Age 'enamels' from Wales.

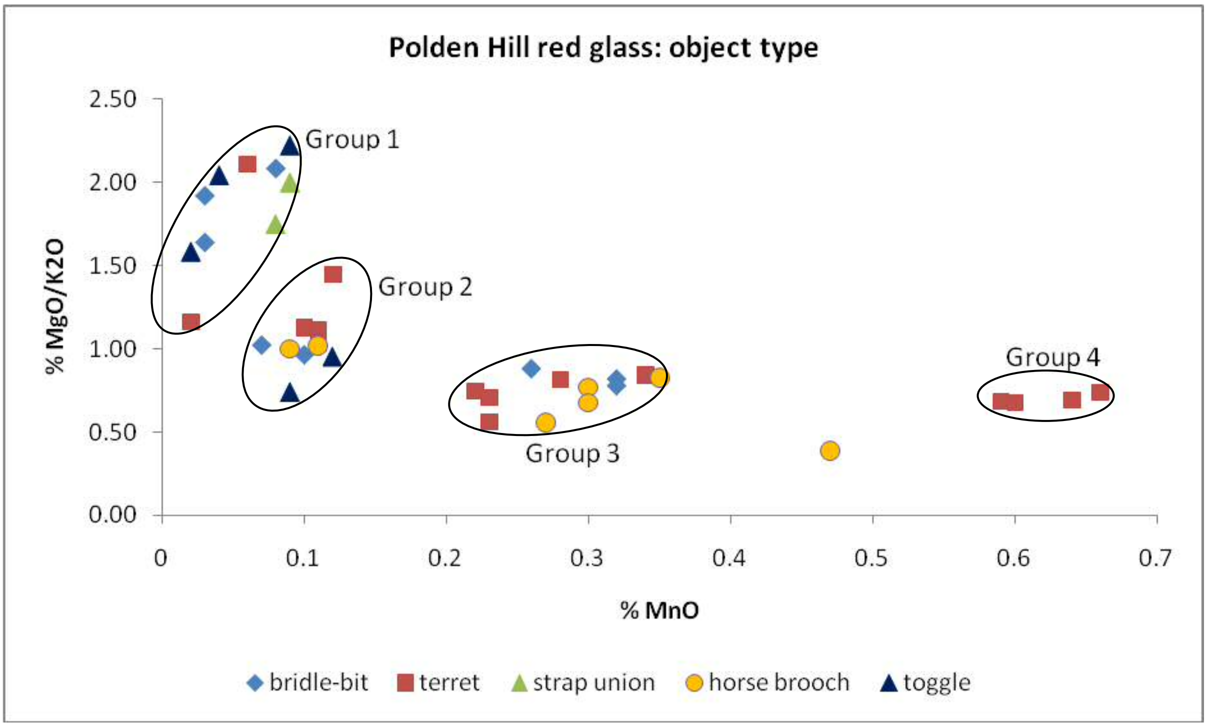


Figure 6. 70: Four 'groups' of artefacts separated by plotting manganese oxide levels against magnesia/potash levels.

The use of manganese oxide, magnesia and potash in the scatter diagrams seem to subdivide the Polden Hill glass into four sub-categories, plus the outlier mentioned above. These are referred to in the text below as 'Groups 1, 2, 3 and 4'.

Group 1	Group 2	Group 3	Group 4	outlier
Strap union 77a Strap union 77b				
Toggle 143a Toggle 143b Toggle 143c	Toggle 142a Toggle 142b			
Bridle-bit 75a Bridle-bit 75b	Bridle-bit 70 Bridle-bit 71	Bridle-bit 68a Bridle-bit 68b		
Bridle-bit 76		Bridle-bit 69		
Terret 100a Terret 100b	Terret 95a Terret 95b	Terret 96a Terret 96b	Terret 88a Terret 88b	
	Terret 98a	Terret 94	Terret 90	
	Terret 98b	Terret 91b	Terret 91a	
		Terret 102		
	Horse brooch 78a Horse brooch 78b	Horse brooch 113a Horse brooch 113b		
		Horse brooch 112a		Horse brooch 112b
		Horse brooch 79		

Table 6. 3: List of samples taken from different objects, and different types of objects.

There is, though not universally, some correlation between the types of object and the grouping of the glass. Glass from the strap union and the toggles only occur in 'Groups 1' and '2'; Group 4 only contains terrets. The strap union and horse brooches are the four most elaborate artefacts in the hoard, incorporating similarly spectacular designs on large flat surface substrates; however, all show very different design elements, and mostly have glass from different groups (figure 6.70; table 3).

Glass analysis and the Polden Hill hoard

This analytical data on the glass composition can be looked at in a variety of ways in detail to see whether further patterns emerge.

The analyses in the following scatter diagrams relate only to objects with surviving glass inlays; many of the other objects, especially pieces of horse equipment, show similarities in the appearance of the metal and decorative techniques, but obviously cannot be used with this data set.

Manufacture

There are several traits visible on the objects which can be used to categorise them, and which often relate to the original manufacture of the artefacts.

Producing recesses for glass inlays

This involves determining whether such features made for the decoration of inlaid glass on the artefacts were cast into the object via the wax prototype, or later cut or drilled into its surface. (figure 6.71; 6.72; 6.73).

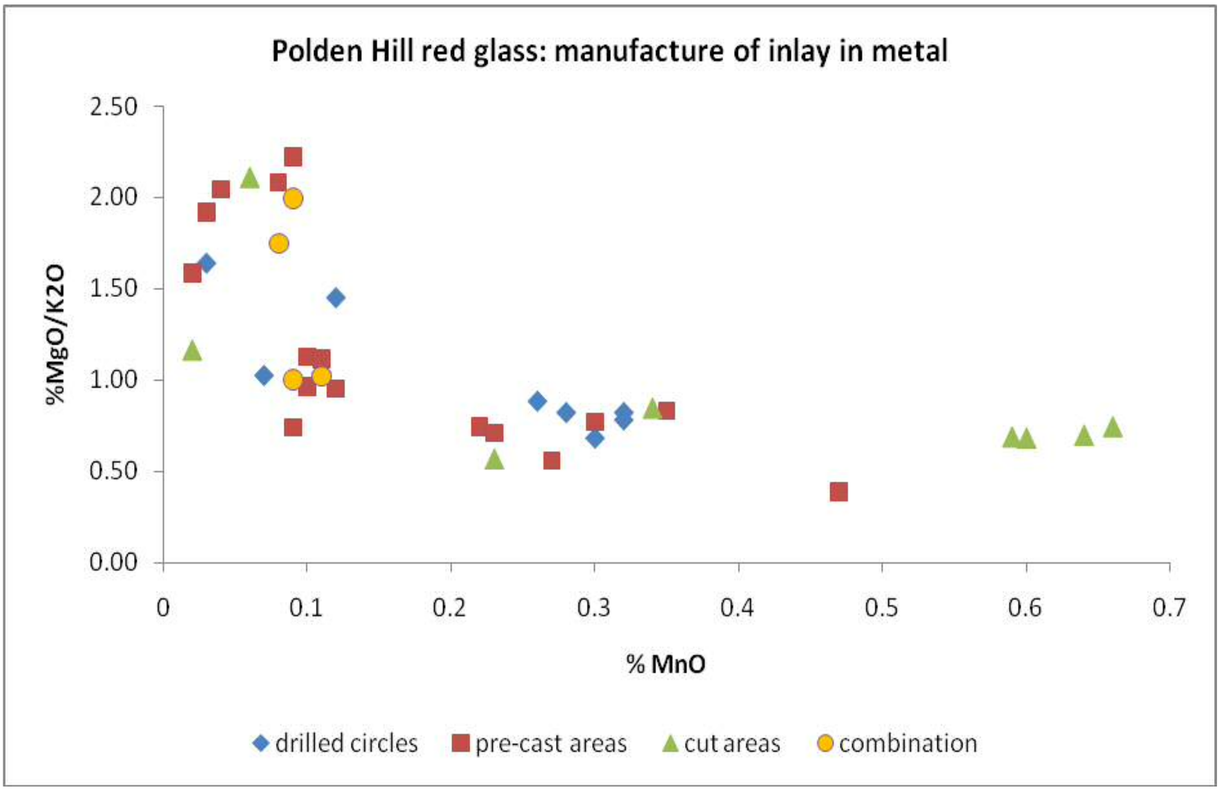


Figure 6. 71: The scatter diagram here shows a mixed picture; different methods of inlaying red glass were used for a range of glass compositions, except for in 'Group 4'.

Figure 6. 72: Drilled circles on bridle-bit 46.3-22.77; recesses cast in to horse brooch 1889.7-6.78.

Figure 6. 73: Curved triangles cut into the metal post-casting on the terret 46.3-22.90; combination of techniques for inlays, drilled holes and cast-in recessed shapes on the horse brooch 1889.7-6.78.

Sets of objects

If sets of objects, for example pairs of bridle-bits or sets of terrets are plotted (Brailsford 1975), it can be seen that a few inconsistencies arise (Figure 6.74). Although most sets occur within groups; the terret set dominating ‘Group 4’ also has a couple of glass inlays within ‘Group 3’. Six samples were taken from these four objects (table 3); there was not enough intact and undegraded glass to take two samples from each object. The samples from terrets 46.3-22.88 and 46.3-22.90 are both in ‘Group 4’; the sample from terret 46.3-22.102 is in ‘Group 3’, whereas terret 46.3-22.91 has one sample in both groups.; it is interesting that these terrets have decoration which was applied after the objects were cast.

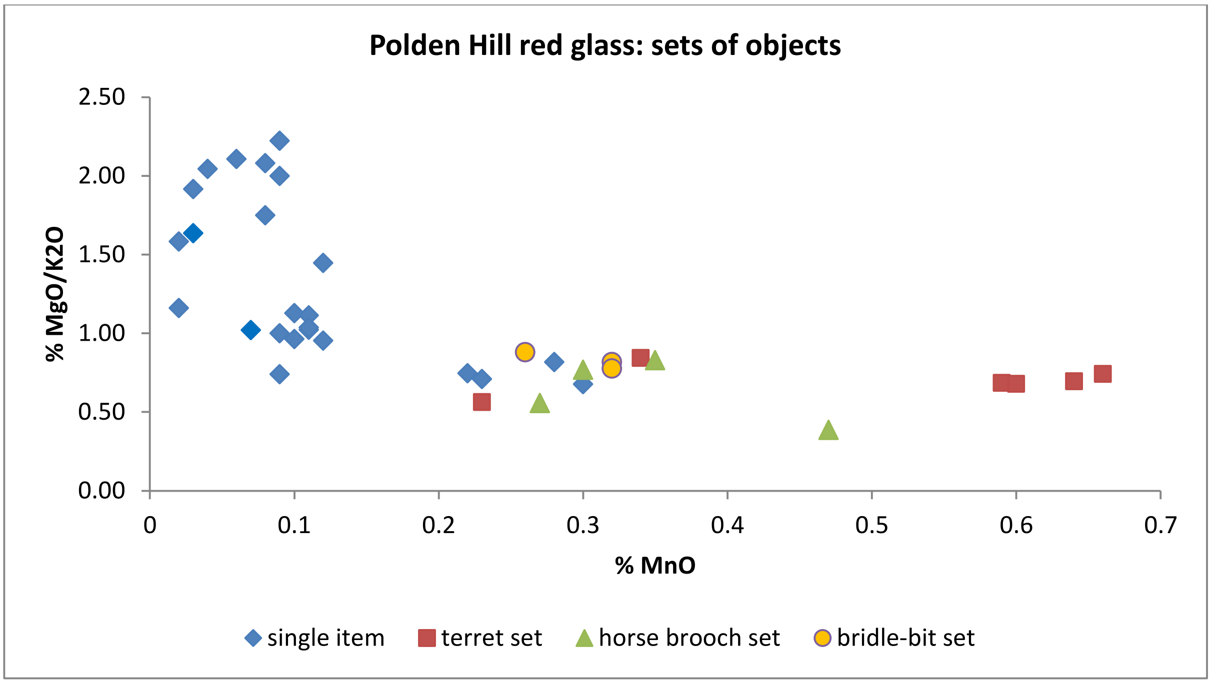


Figure 6. 74: Sets/pairs of sampled objects according to Brailsford (1975); other sets exist, but are either not decorated, or not enough glass has survived for sampling.

Shape and design

Complex designs are present on all the horse brooches and the strap union; i.e. the large two dimensional artefacts, where the design can be fully embellished without encumbrance from the three-dimensional character of the object. Complex designs are also present on the flat side of many of the toggles; all these types of objects are only decorated on one face.

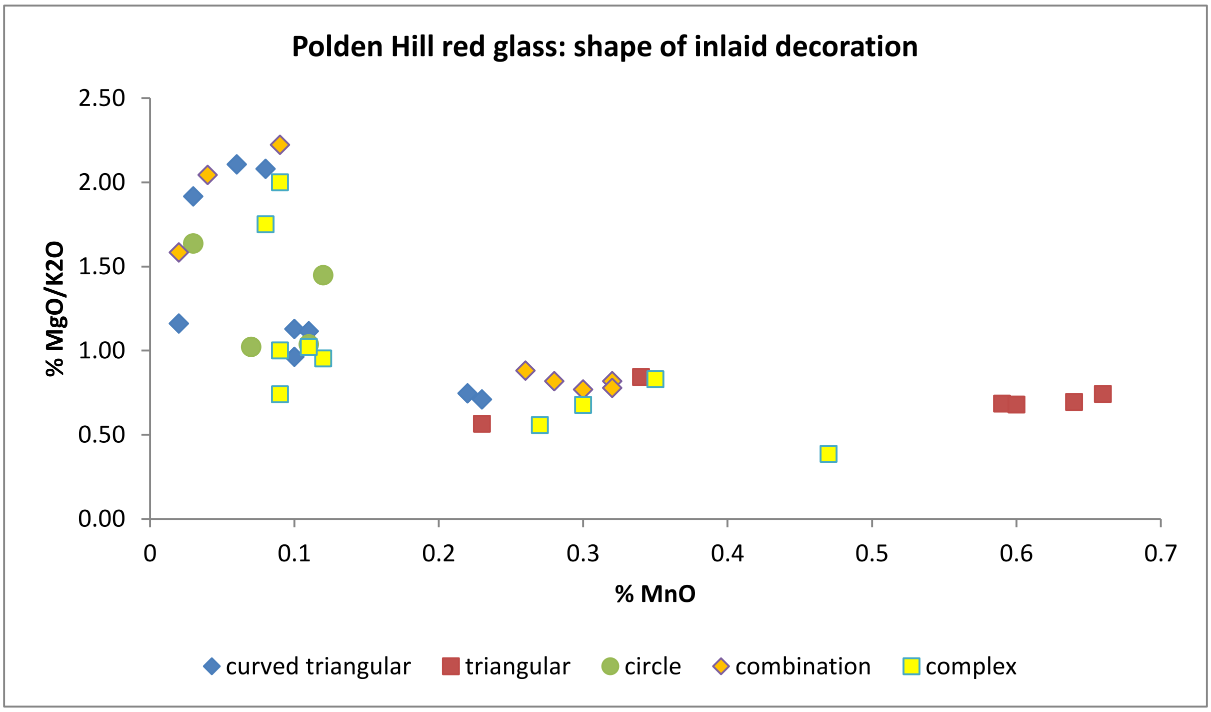


Figure 6. 75: Shape and complexity of inlaid decoration.

Figure 6. 76: Examples of a 'curved triangle' or 'fin' motif (Jope 2000, 381) on terret 46.3-22.100 and a 'triangle' on 46.3-22.102.

Cast-in features

The picture is mixed for cast-in features, apart from those in 'Group 4'. The cast-in features on the horse equipment, other than recesses for glass, are partly object related: no toggles have this type of decoration; horse brooches and harness fittings are flat and able to incorporate voids into the object as part of the design scheme. All the bridle-bits and the majority of the terrets in this hoard have wings or lips. The use of lips (lobes) *and* cast-in lines occur on one terret only in 'Group 3' (46.3-22. 96).

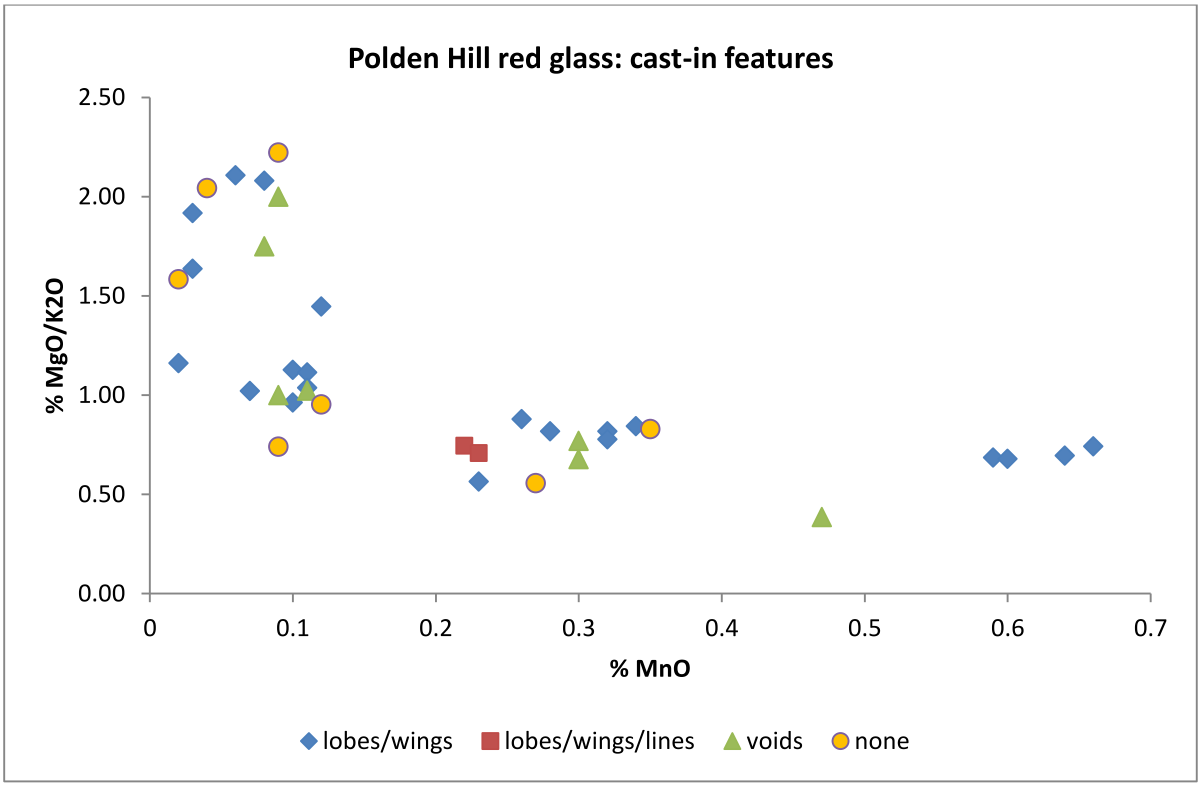


Figure 6. 77: Features made in the wax prototype when using investment moulds, before they are cast into bronze.

Figure 6. 78: Cast-in lines surrounding the triangles on terret 46.3-22.96; voids in the design of strap union 1889.7-6.77.

Figure 6. 79: ‘wings’ on bridle-bit 46.3-22.69 and lips on terret 46.3-22.100.

Post-casting embellishment

The following categories are other decorative features which are not cast into the bronze, and are not infilled with glass, but were applied after manufacture. This includes scribed lines, dots, and punched decoration. The results show a similarity between ‘Group 1’ and ‘Group 2’; ‘Group 4’ is again uniform, but ‘Group 3’ shows the largest variation in post-manufacture design. Again, a one-off and unusual terret is the exception 46.3-22.98 (Group 2) (figure 6.60).

Figure 6. 80: Lines and dots scribed into the surface of bridle bit 46.3-22.69 and lines on terret 46.3-22.100.

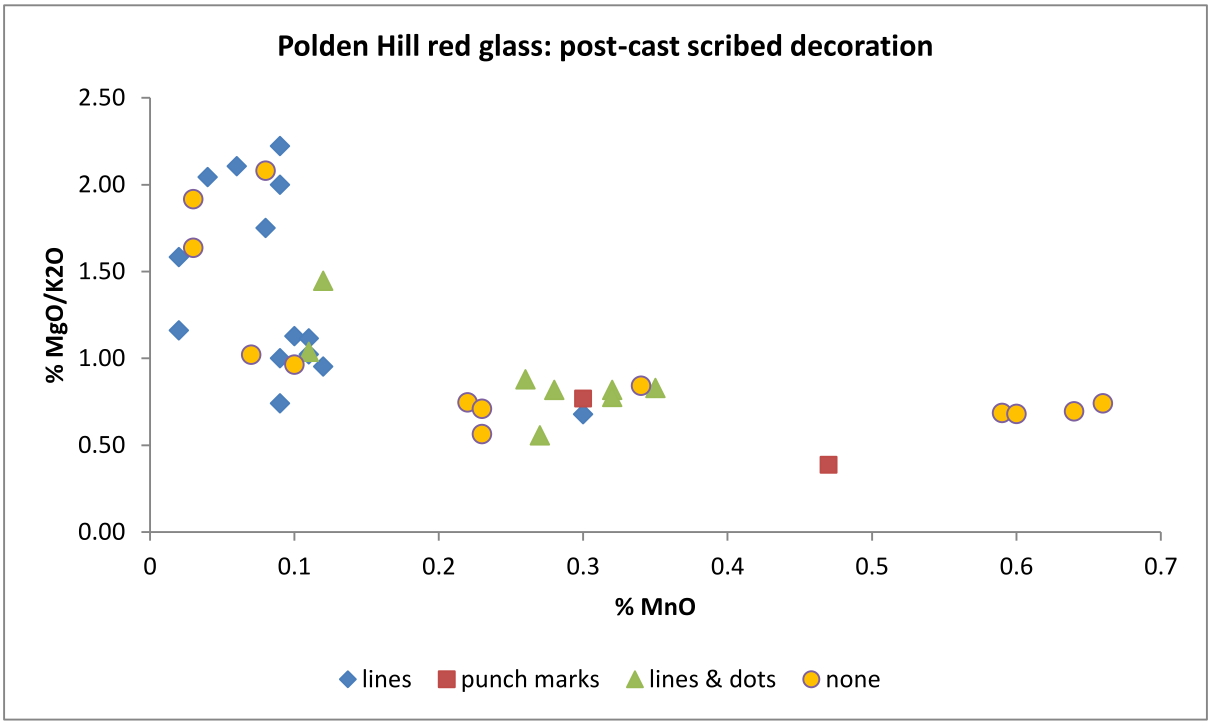


Figure 6. 81: Post cast scribed decoration. The picture is again mixed; 'Groups 1' and '2' are largely similar, and 'Group 4' is again uniform.

Figure 6. 82: Punched decoration on the top half of the horse brooch 46.3-22.112.

Summary of manufacture of objects in relation to glass groups

The above information and scatter diagrams point to a complicated and incomplete picture of decoration on the Polden Hill objects. The data only deals with objects with extant glass inlays, so does not include those where the glass is missing or now totally degraded (as with a number of the toggles), have decoration applied in other ways, or have no surface decoration or 'embellishment'. However, the variety of applied decoration to different objects where glass is extant show that many were decorated or embellished at different points in their manufacture or use, and that there are a number of varied and progressive technologies. Modes of decoration vary: there are simple cast objects with no additional embellishments; complex casts (including all bridle-bits and lipped terrets) which have lips or wings; embellished complex casts which employ decorative features such as recesses, voids, and lines formed within the wax prototype; added embellishments where post-casting decoration such as cut recesses, scribed lines, drilled recesses, punched dots, and punched circles are applied. And finally there is the application of a coloured finish to the metal surface.

Some objects have been decorated in a different sequence of production, but aiming for the same outcome in terms of colour, and onto the same objects in terms of function. The red glasses used for the decoration, with one exception, are very similar, but can be divided into four groups, (possibly three if 1 and 2 arre linked together). It appears that inlays from separate 'analytical groups' (MnO v MgO/K_2O) are mostly also from separate 'stylistic sets', however, at least one set of objects uses two different red glass types (46.3-22.88; 46.3-22.90; 46.3-22.91; 46.3-22.102). For at least two objects, glass from different groups is used on the same object, as with 46.3-22.91(b) and 46.3-22.112(b). It is also interesting that the four most decorated objects: the horse brooches and the strap union, are all stylistically unique within the hoard, and mostly use different group types of glass.

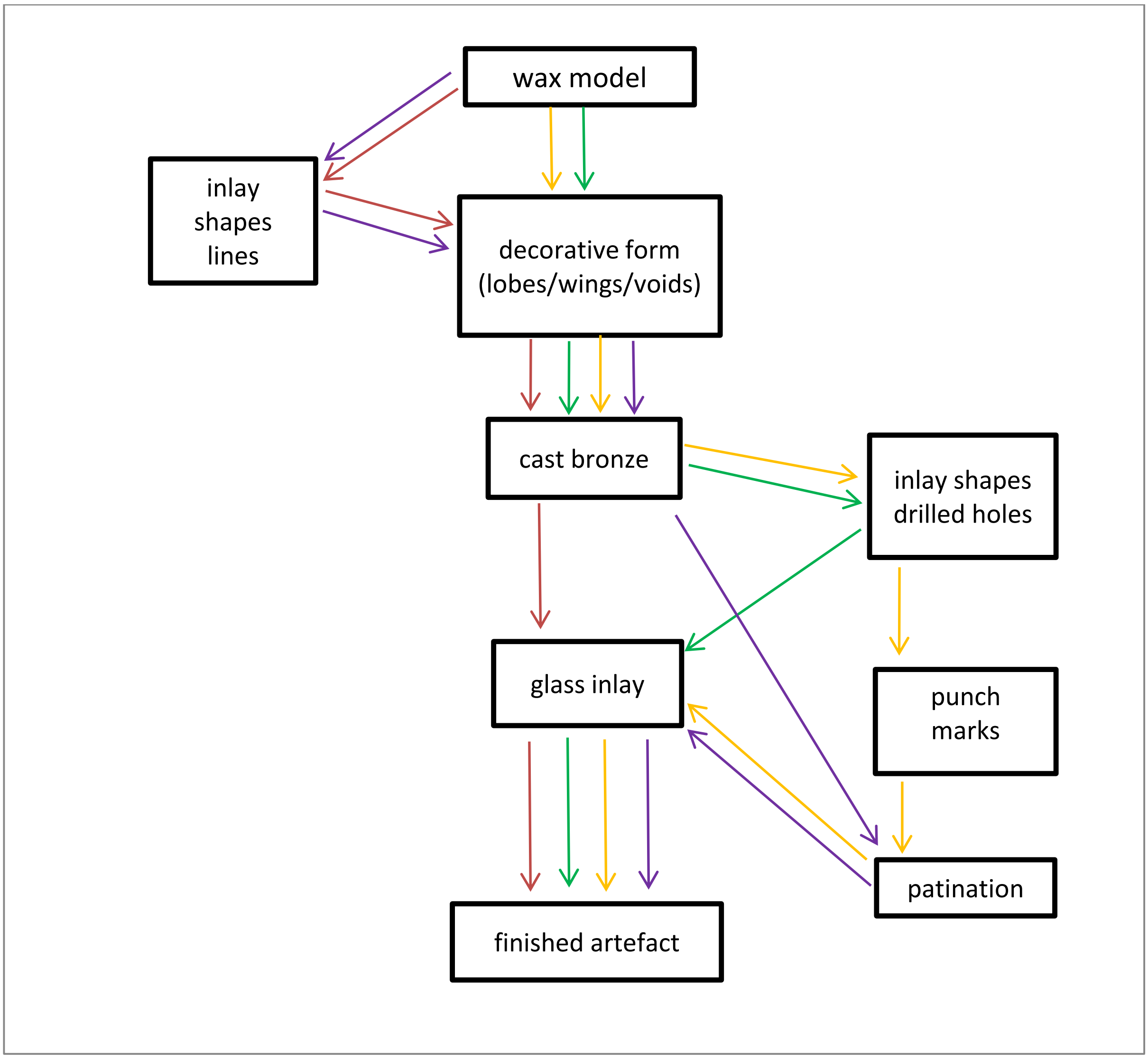


Figure 6. 83: Objects from the Polden Hill hoard with glass inlays. Some of the routes of manufacture followed from making the original wax prototype to the finished and decorated artefact.

Analysis of the condition of the objects and the glass inlays

The condition of the objects could give some insights as to how they were treated before or at the time of deposition into the ground; sometimes this can be observed by the condition of the glass and the metal. Unfortunately, differences in the appearance of some, but not all of the objects have altered since they were discovered due to cleaning and conservation work which has not been documented.

Completeness

One of the most straightforward categories to assess is the completeness of each object; it is usually possible to tell where objects have been re-adhered or restored. Objects from many of the Late Iron Age hoards of this type show some degree of deliberate breakage or the inclusion of partial objects, so this is potentially a useful category; some correlation between the completeness of the objects in relation to the composition of the glass can be seen (figure 6.82).

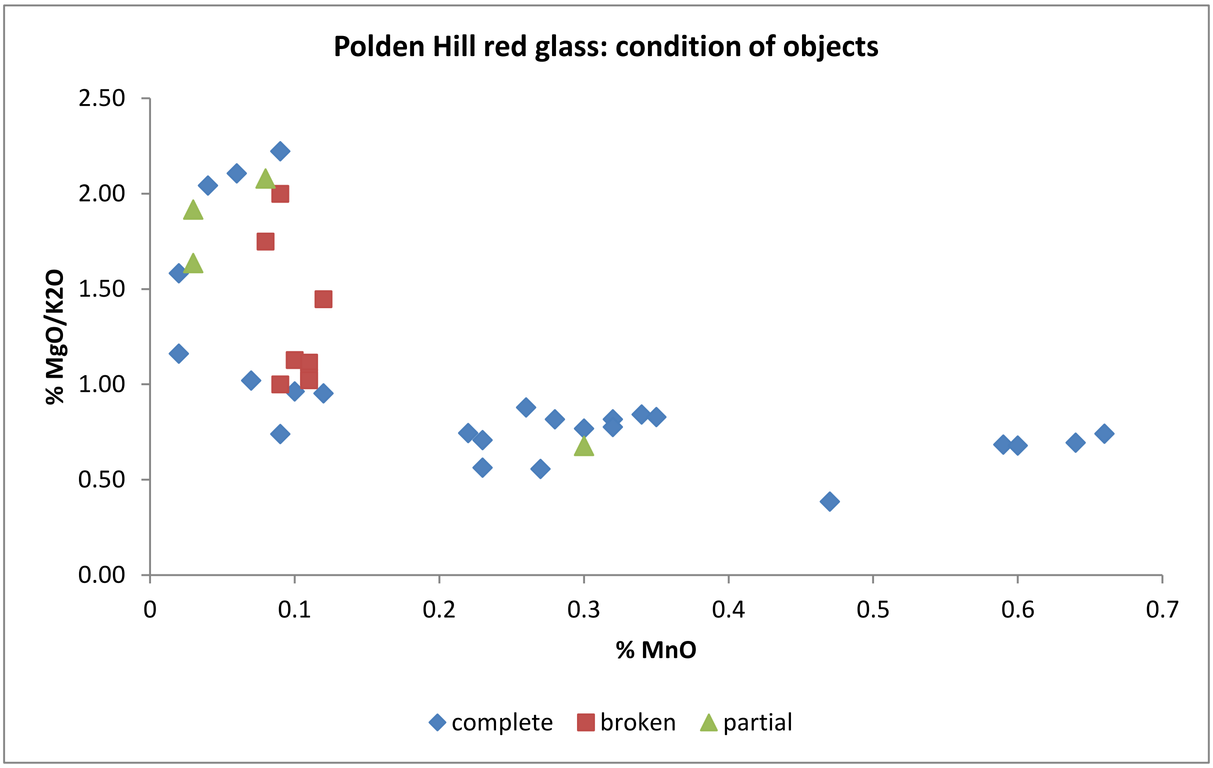


Figure 6. 84: Three broken and partial objects are from Group 1 and 2 (more than one sample taken), with one object from Groups 3 (horse brooch 89.7-6.79), and none from group 4.

Burning

Burning objects seems to occur prior to burial (as well as breakage; this particular hoard was said to have come from a circular pit with a burnt bottom (Harford 1803, 91). There are often indications on the surfaces of artefacts as to whether they have been burned; a common sign is the presence of charcoal within the dirt and outer corrosion layers of the object. However, for this hoard most objects have been cleaned and any of this kind of evidence removed. A second surface indication is the appearance of the corrosion products; areas of translucent green and blue corrosion products often indicate the surface was once burned (figure 6.82; 6.85). However, with this factor similar problems occur, as many, though not all the objects have been cleaned down to the metal surface, or to a patination layer below this type of corrosion.

Figure 6. 85: Uncleaned, partial, encrusted bridle bit (46.3-22.75): the original surface corrosion survives on this object allowing the condition to be assessed more accurately.

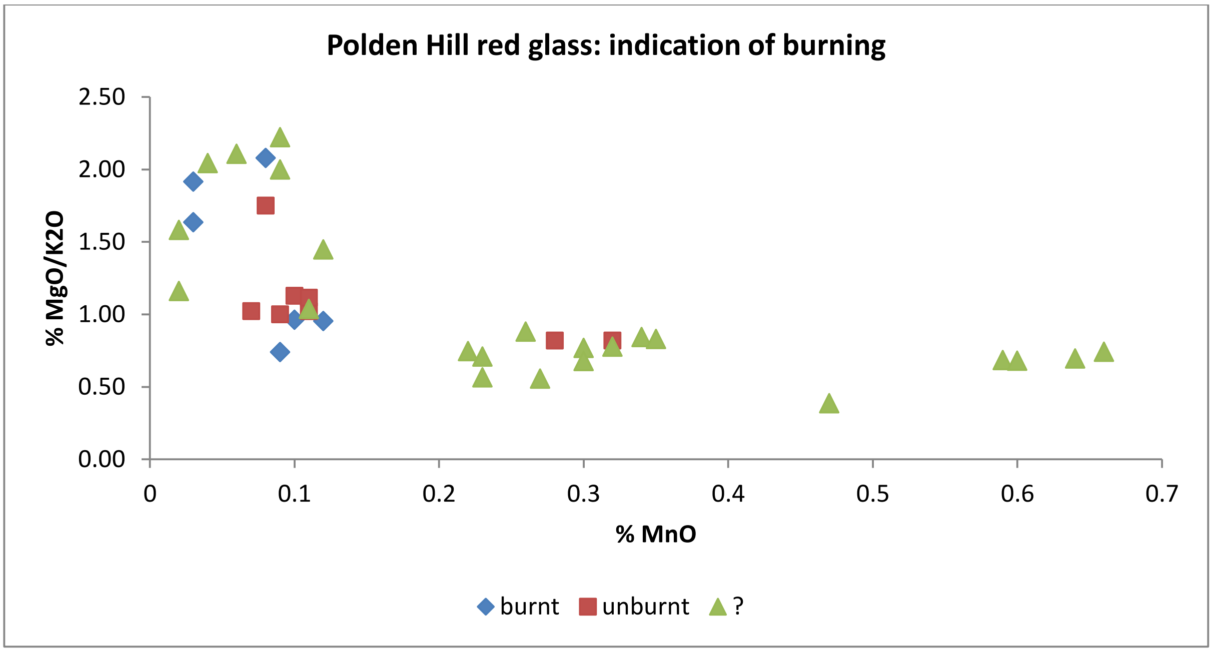


Figure 6. 86: The scatter diagram above is therefore more subjective than some; however, the pattern remains similar to that for broken object, with all the burnt objects occurring in Groups 1 and 2.

Figure 6. 87: toggle 46.3-22.136 shows a cleaned bronze surface with degraded enamel and some remains of a highly crystalline green and blue corrosion product on the surface, often an indication of burning (Sue Bridgeford pers. comm.). In contrast, toggle 46.3-22.142 has green copper corrosion products overlying the bronze surface, and some red glass is still extant.

Condition of the metal and glass

The condition of the surface can also be assessed by looking at the colour. One of the most striking features of some of the horse equipment from this hoard is the glossy black surface patination, which seems to have survived burial and cleaning in many cases. Some areas of this black surface have worn away to reveal the underlying bronze-coloured metal. Again it is also possible that on some objects this layer has been stripped away during cleaning. This means that the results below probably carry some distortion, but the patterning in relation to the glass does seem to be consistent.

Black surface patination occurs in 'Groups 2' and '3' (figure 6.86); encrusted surfaces only survive from 'Group 1' and the black/bronze colour is present in 'Groups 3' and '4'.

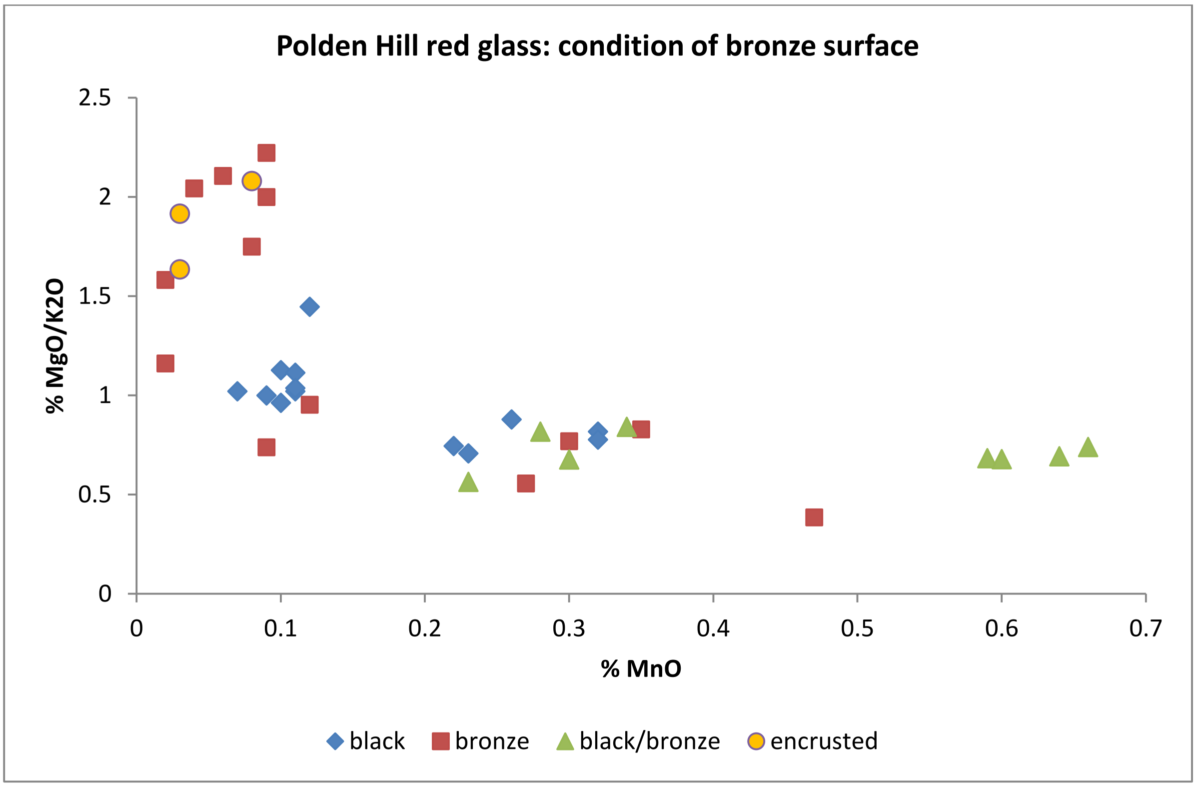


Figure 6. 88: Surface condition of the objects

This is important in assessing the life history of an object; as encrusted or burnt surfaces occur within a particular group, this implies a specific treatment of these objects prior to burial, and one distinct from the surface finish applied by the bronze smith. The bronze/black objects were possibly originally black, but subsequent wear or recent cleaning has removed some of the surface patina.

The exposure of the bronze-coloured metal around the inlayed areas on the terret 46.3-22.94 (Figure 6.87) suggests that the patination was applied before the glass. The visible bronze probably represents an abraded area occurring when the glass was polished down to reveal its bright red colour, and so it lay flush with the surface of the object.

Figure 6. 89: Terret (46.3-22.94). Largely intact shiny black surface patination; areas of inlaid glass with bronze metal showing.

Wear

The majority of bridle-bits show wear at the central link, and sometimes the patination is worn on the ring. Wear on the decorated terrets and horse brooches are more difficult to determine; these particular artefacts may have been used less regularly than many of the plain terrets. If the large decorated terrets on the chariot or cart were positioned centrally on the yoke, less wear would have occurred as the reins would probably not pass through these rings.

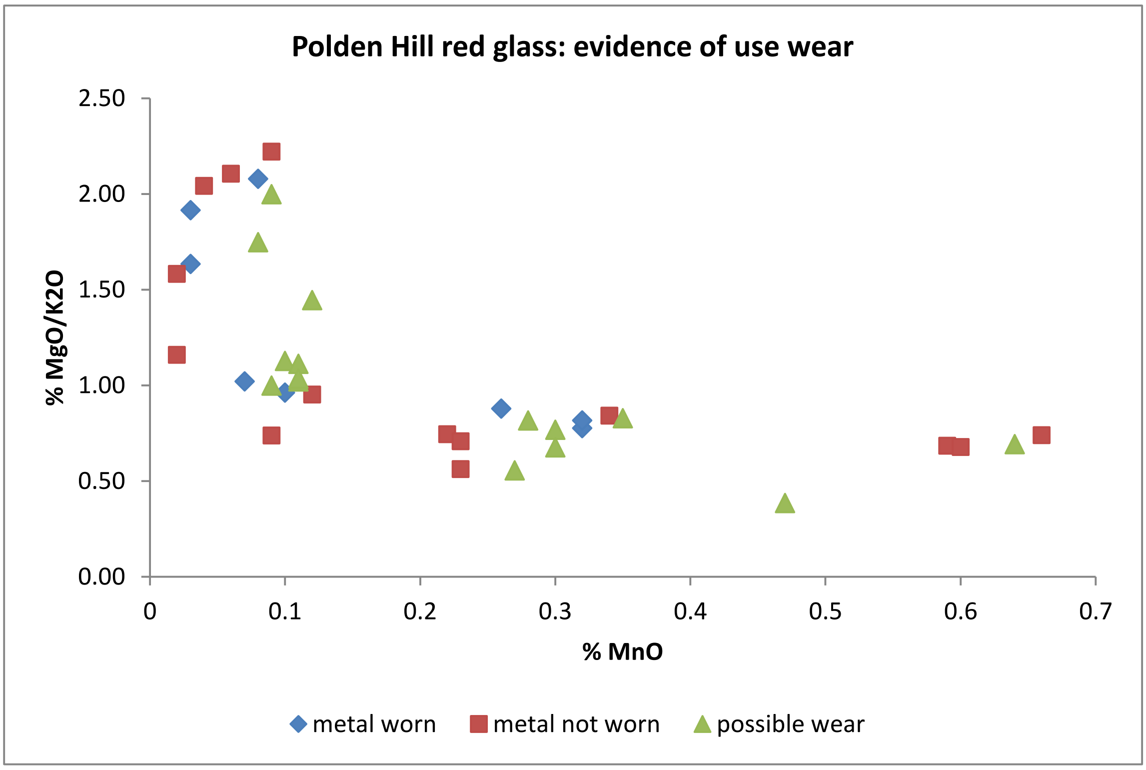


Figure 6. 90: Evidence for wear.

The scatter diagram in figure 6.88 provides a mixed picture; many of the bridle-bits with glass present appear worn, whereas most terrets seem unworn.

Figure 6. 91: Bridle-bit 46.3-22.76, showing how the metal has been worn in the centre of the bit; terret 46.3-22.90: possible slight wear where the patination on the bronze shows a difference in colour and appearance.

Condition of the glass

The pattern seen for the colour and condition of the copper alloy substrate of the objects is repeated to some degree for the condition of the glass itself. Surviving red glass and the encrusted object and glass surfaces mostly occur within 'Group 1', a group where there is no glass surviving as a pale powder. The glass has turned green in objects from 'Groups 2' and '3' only; this again implies different treatments during the life of the objects (figure6.93).

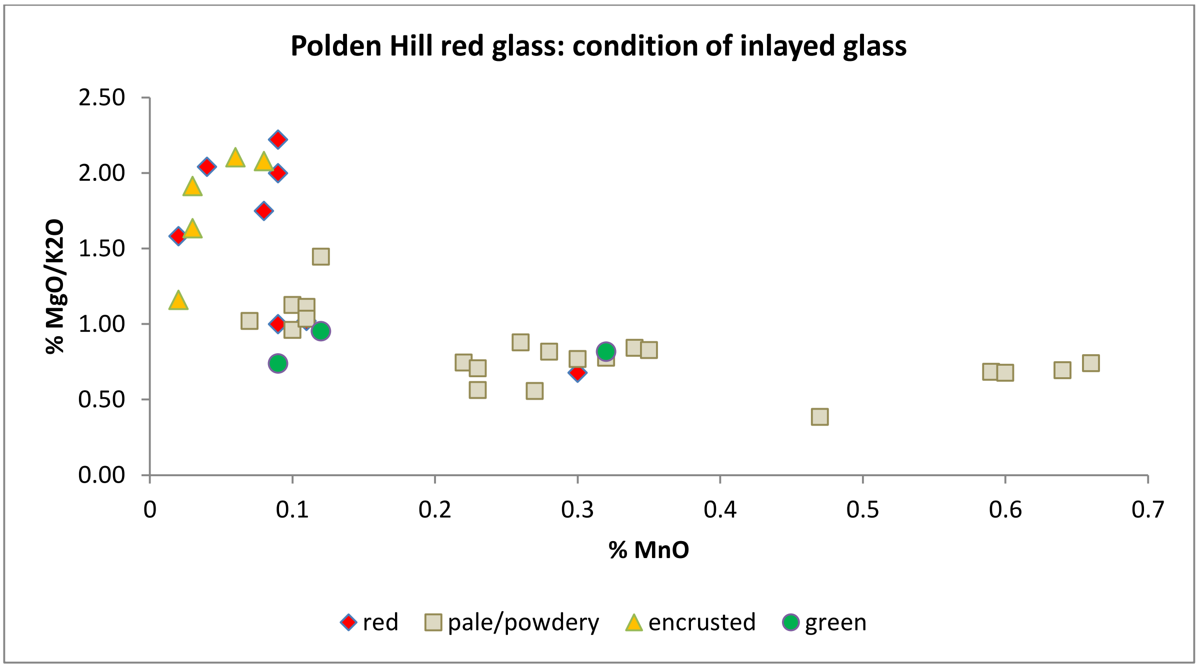


Figure 6. 92: Condition and colour of the majority of inlaid glass in the sampled objects.

The condition of the metal and the glass as well as the completeness of the objects shows some correlation; 'Group 1' shows consistently more variation. It is impossible to say at what point many of these distinct physical characteristics developed, but the diagrams indicate different treatment to 'Group 1' in terms of breakage and for signs of burning, although this is difficult to define objectively due to modern cleaning treatments. Burning and breaking are two features noted in other similar hoards such as Seven Sisters (Davies and Spratling 1976) and Stanwick/Melsonby (Macgregor 1962). Burning could have contributed to other factors of the objects' condition; encrustation formed rapidly (possibly by heat at the surface of the object), could have helped protect the glass from later erosion through weathering and burial (Figure 6.92), and as stated above, it is difficult to know how extensive this corrosion may have been when newly excavated. Many of the pale powdery inlays have bubbles at the surface, an indication that they too could have been burned (Figure 6.91).

Figure 6. 93: Cleaned decorated terret 46.3-22.96. Many of the inlays survive as pale powdery degraded glass; sometimes with air-bubbles on the surface; small amounts of preserved red glass survive.

Figure 6. 94: Bronze coloured objects (strap union 1889.7-6.77; toggle 46.3-22.143) where the red glass has survived well, but the surface appears stripped, with small amounts of black surface patination remaining.

Figure 6. 95: Green surface colouration of glass inlay on bridle-bit 46.3-22.68, plus shiny black patination. This is in contrast to the dull grey/black colour overlying bronze on the horse-brooch 1889.7-6.79; this surface finish may well be the result of burning or partial cleaning.

By using a detailed assessment of the condition of objects, it was hoped that information could be gathered which could add to the understanding of the manufacture, use and deposition of the artefacts; this included factors such as patterns of wear and breakage contributing to the history of the object before or at the time of burial. Different 'Groups' of objects, defined by the composition of the metal and the inlaid glass, appear to have been treated differently between manufacture and burial. Many are similar but not identical in style, and analysis suggests certain objects were manufactured at the same time; it is interesting that despite different use and treatment, these pieces were again gathered together from several different sources for deposition.

During burial, pre-treatments such as burning, plus soil conditions in the ground would have had a significant impact on the appearance of the objects. This picture is further complicated by the largely unrecorded treatment of the objects since their discovery. Post-burial recovery, storage, treatment, and study will all have impacted on the objects to some degree (figure 6.94), but careful examination has still provided information.

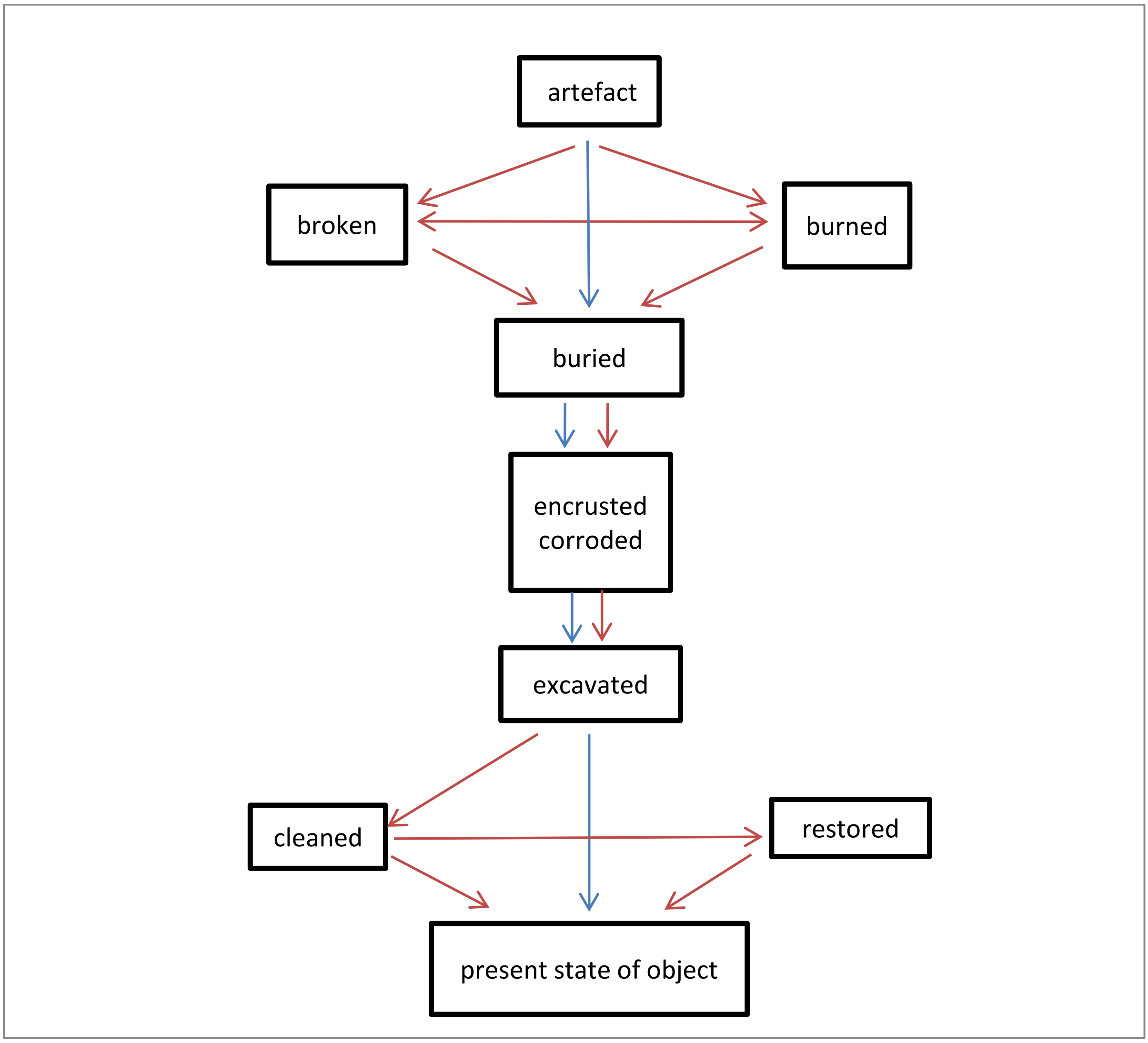


Figure 6. 96: Objects from the Polden Hill hoard: possible history of the object at the end of its life, during burial and after its discovery.

Summary and Discussion

As with the other hoards (Chapters 7-10), the analyses provide hints at casting methodologies and deposition practices; this can be gleaned by examining a whole series of objects from one context; differential burial cannot account for differences in composition, condition and patination etc.

Within the hoard there are patterns in the types of trace elements present and absent; arsenic and silver have proved useful; there is virtually no nickel, and limited antimony, elements which have been used as discriminators in other hoards such as Llyn Cerrig Bach (Anheuser & Davis 2007). This could suggest the relatively limited supply or exploitation of resources within a particular geographical area.

Points observed from the analyses

- There is no real discrimination for different types of bronze object using copper and tin (figure 6.11)
- The tin to bronze ratios were not selected here for particular uses (wrought or cast bronze), but form a fairly concise group with the compositional range of 7-15 percent tin and 85-92 percent copper.
- Definite groups of objects are discernible through trace element analysis; the high arsenic bridle-bits 46.3-22.77 and 46.3-22.78-80 (figure 6.12; 6.13) have large rings and are broken; they are the only bridle-bits with this composition and are physically and elementally distinct. High silver and antimony levels identify another distinct pair of bridle-bits 46.3-22. 72 and 46.3-22.74 (figure 6.13; 6.14; 6.45) possibly showing that different casting episodes were undertaken for specific types or groups of object.
- Low arsenic levels define a distinct terret group; 46.3-22.101; 103; and 104; 46.3-22.89 look analytically dissimilar to the others in the set due to different trace elements present, and could be prototypes (figure 6.56). Low arsenic levels are also discernible in single items from pairs; one pendant hook from a pair (46.3-22.108); one shield boss from a pair (46.3-22.116) and one toggle from a set of four similar items (46.3-22.136) (figure 6.12).
- Low arsenic levels are noticeable in the strap union and all the horse brooches (figure 6.12), except for the component 46.3-22.112b (from the large two piece brooch, which is regularly analytically exceptional), suggesting these might have been made relatively late in comparison to other items in the hoard (See chapter 4).
- Objects with low arsenic and silver form a distinct group; this includes two out of three of the cuirass hooks (46.3-22.9 and 10): the third is possibly a prototype as with other pairs and sets of objects (figure 6.13).
- The limited presence of certain trace elements suggests a limited use of ore sources for objects from this hoard, which in turn implies a relatively restricted trading circle using specific contacts that use specific ore sources. There is a lack of antimony and especially nickel in many objects, elements which in various combinations with silver and arsenic are often present in copper ores and are often present in other Iron Age copper alloys (Dungworth 1997).
- Personal ornaments show less consistency in relation to the presence of antimony (figure 6.14; 6.15); those which contain more include the cuirass hooks (46.3-22.109-111), plus one brass dolphin brooch (46.3-22.126) and the brass wire on the torc (46.3-22.117/118)
- The vessel hoops, again a unique type of object for this hoard, also contain some antimony and appear to have a relatively unusual signature (figure 6.14; 6.15).

- One large terret contains significant antimony (46.3-22.100); this object is both elementally and decoratively distinct to all the other terrets (figure 6.14; 6.61).
- There is no noticeable difference in the elemental composition of objects with specific cast in decorative features such as milling; however, there is a difference in trace element composition between bridle-bits inlaid with red glass (figure 6.47) and between bridle-bit and terrets not inlaid with red glass (figure 6.29). Objects with different surface patinations show distinct compositional groups.
- On the whole, but not universally, patination types match major element grouping; this could mean that most patinated objects were cast in the same batches (figure 6.58; 6.59; 6.86).
- For terrets, green surface patinations are present on similar types or groups; whereas black patinations seems to occur on individual, large and highly decorated single pieces (figure 6.58; 6.59; 6.86).
- Figure 6.86 shows groups of encrusted objects; this implies different treatments before burial were contributing to the condition of the surface.
- Brass is used for objects associated with dress and personal adornment; (some brooches, the torc and the cuirass hooks) (figure 6.11).

Sets or pairs of related objects tend to have similar surface finishes, and major and trace element content for metal and glass (where present). The copper alloy, as with most Iron Age objects has been carefully selected; there are no leaded artefacts, despite the fact that the vast majority are cast, and only one part of one bridle-bit has just enough zinc to qualify as a gun metal.

The variety of artefact types, their variable condition, for example, burnt or broken etc. suggests a series of complex interrelated social discourses 'valuable objects were selected for deposition indicating the central role of religion and ritual activities in social negotiations of power' (Joy 2011, 413).

It appears that the use of specific artefact types, and the materials from which they were made were used as modes to assign identity, both within a group of people, as with the horse equipment, and as individuals using personal dress accessories and ornament. Within the context of the hoard, these could act as visual symbols of communal values and individuality; old metal (bronze), and new displays of personal adornment; the latter expressions becoming increasingly possible with the arrival of an influx of materials and technologies from which to form an increased and varied appearance through material culture.

Chapter 7. The Seven Sisters hoard

Introduction

The Seven Sisters hoard consists of 37 pieces of metal work that were discovered in 1875 (Romilly Allen 1805; Davies & Spratling 1976, 121). The artefacts were initially extensively reported on and illustrated by Romilly Allen in 1905 (Romilly Allen 1905), and then re-evaluated by Davies and Spratling (1976) who reinvestigated the hoard's discovery as well as the artefacts themselves. Within the hoard there is Roman and native British material, plus several ingots, casting jets and pieces of 'scrap' metal which are less easily categorised by style or period (figure 7.1).

Figure 7. 1: All the objects from the Seven Sisters Hoard, except strap union 1928, 1-16 which is in the British Museum. (Photograph: ©National Museum of Wales).

The location of the hoard was in an area north east of Neath (figure 7.2). There is a distinct ridge running between the valleys of the rivers Neath and Dulais, along which runs a Roman road – beside which are two small forts. On the eastern side of the ridge a system of streams runs down to the River Dulais. In 1875 'a locally memorable flood' (Romilly Allen 1905, 128) probably led to the collapse of the adjoining stream bank.

> *'The bronzes were found scattered about in the bed of one of the streams… after a severe storm. The rush of water washed away part of the north bank, and it is evident that the bronzes had been buried in the soil thus removed'*. (Romilly Allen 1905)

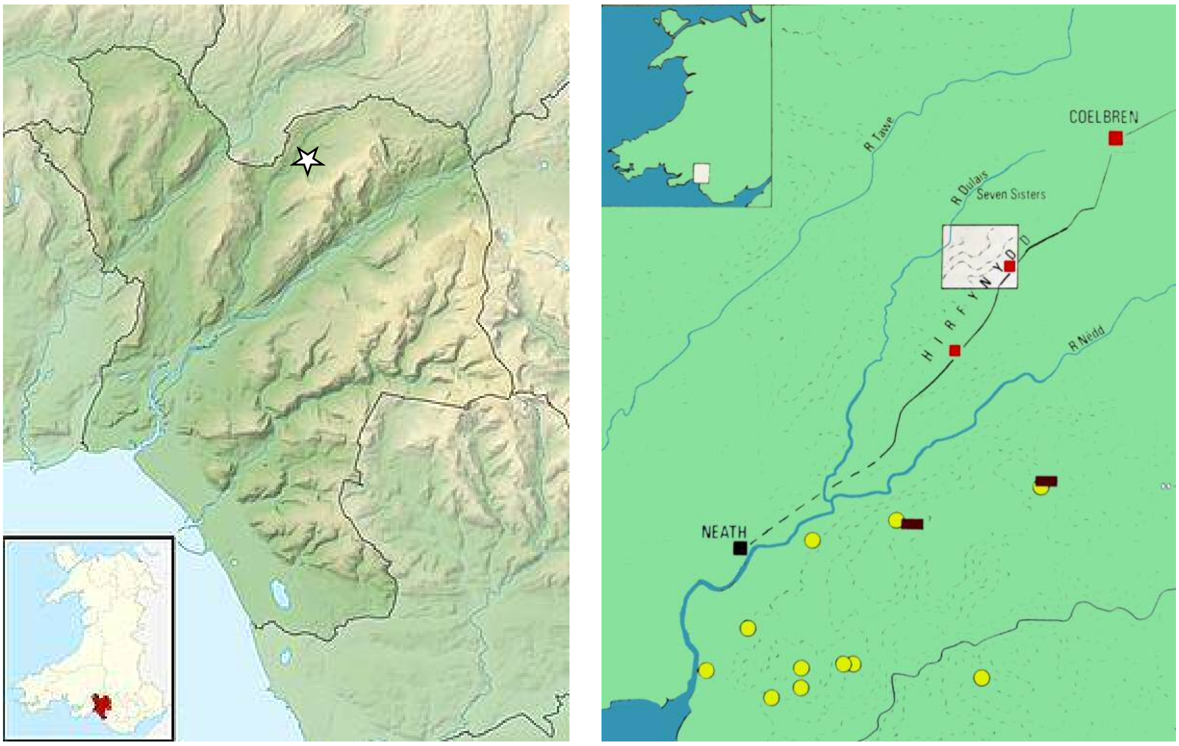


Figure 7. 2: Map of the locality of the Seven Sisters hoard (http://en.wikipedia.org/wiki/Mynydd-y-Gaer, and after Davies and Spratling 1976, 122). Squares = Roman forts and fortlets; rectangles = Roman marching camps, circles = Iron Age hillforts and related enclosures.

Romilly Allen (1905), when talking of the artefacts within the hoard states that:

> *'It is very doubtful whether all were recovered when we consider the strength of the current; some may have been buried in the shingle of the bed, and others washed into the Dulais. As the objects were treated as playthings of the children at the farm for many years, it is quite possible that some of them have been lost'.*

Romilly Allen believed the horizontal area of land above the stream was 'a suitable spot for a house', and cites the discovery of 'rough pottery' found some years earlier in a trial shaft sunk for coal in the area as further proof of 'ancient human occupation' Davies and Spratling agreed that this would make a good area for a settlement and proposed that the site was a native homestead, incorporating a bronze smith's workshop, probably belonging to a farmer/craftsman. However, they did note that native settlements in this area were 'conspicuously absent' (Davies and Spratling 1976, 40): it was the nature of the composition of the hoard that most directly led them to this conclusion. They did not believe the hoard was deposited by Roman troops – as it was neither near the road, the small forts or a marching camp. Equally they dismissed the idea of the hoard as a votive deposition, as it was not found either in a river or a boggy area (both of which were, however, in close proximity to the original find spot).

Davies and Spratling (1976) believed native British people collected the hoard as scrap, and that the Roman material could have fallen into their hands during one of the many attested military engagements in this area during the protracted period of warfare. They do not believe that Roman military metal would have been traded as scrap (Davies and Spratling 1976, 140); metal was recycled scrupulously at military sites and very rarely discarded as rubbish (Jackson 1990, 22). Many items in the Seven Sisters hoard were broken, there was a mixture of types of artefact, and some objects appeared worn (for example the native strap unions), while others were pristine (e.g. the pendant hooks and one of the terrets). The majority of the objects also appeared to derive from two differing but contemporary native styles; Davies and Spratling believed the hoard was explained in the context of a workshop in which 'both founding and sheet metal working were carried out' (1976, 138).

As Romilly Allen states, the hoard was found in a streambed in 1875, then kept in the possession of a farming family in the Dulais Valley. It was not until 1902 that the finds were purchased (by a local antiquarian Dr W Bickerton Edwards) and donated to the Welsh Museum of Natural History, Arts and Antiquities, Cardiff, the immediate predecessor of the National Museum of Wales. In 1927, a relative of Edwards' offered a previously unknown strap-union from this hoard to the British Museum (Brailsford 1953, 62 and plate XI.2). It remains possible that further items from the hoard have remained unfound, lost or not reported. Davies and Spratling reviewed the circumstances of the hoard's deposition but despite their best efforts to re-establish the find-spot (Davies and Spratling 1976, 123-5 and figure 7.2), there is still some doubt as to its precise location.

Davies and Spratling (1976, 137) divided the hoard into three categories: Roman, native British and Roman or native (and considered the last group to be predominantly native). The Roman material consists of military equipment, the date of which appears to be mid first century AD, which agrees with the dating of the Iron Age pieces in the hoard at c.50-75 AD (Davis and Gwilt 2008, 164).

Style of objects in the hoard

Following from Davies and Spratling's categorisation of the contents of the hoard (1976), the objects have been divided into three distinct stylistic groups as follows:

'Curvilinear' Late Iron Age (LIA) also referred to as *Insular La Tène style* material*,* which consist of two 'pendant hooks', five tankard handles and the helmet crest. Also included in this group are four folded sheets of bronze from a vessel, a bronze ring - probably originally from a bridle-bit, and a partially worked billet.

'*Geometric' Late Iron Age style* material*, (GLIA)* which comprised mostly horse gear including two terrets, two bridle-bit rings and two strap union of very similar design, but also possibly the pelta shaped ingots.

Roman material which was also predominantly horse related equipment, but also contained a buckle, and two casting jets.

A further category consisted of the copper lump which could not be ascribed to any of the above groups.

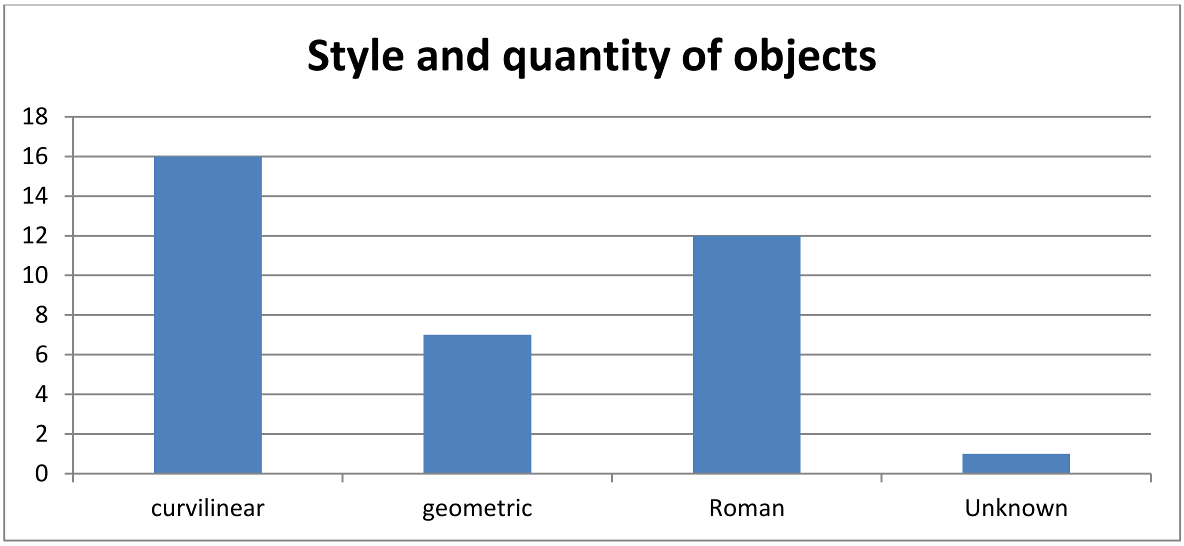


Figure 7.3: Both the 'geometric' and the 'curvilinear' style objects equate to Davies and Spratling's 'native British' material (1976), and are considered Iron Age as opposed to Roman.

Figure 7.4: Seven Sisters 'style' of objects: curvilinear Late Iron Age; geometric Late Iron Age; Roman. (Photographs: ©National Museum of Wales).

Metal compositions within the hoard

Metallurgical analysis was considered in conjunction with a number of aspects of the objects found within the hoard. Their style, function, and decoration were also assessed. When the alloy composition was plotted against the type of object found, some patterns were evident; the apparent relationship between alloy type and function may reflect stylistic/cultural preferences.

Although the majority of the artefacts are bronze or brass, the overall elemental composition of the hoard is as mixed metallurgically as it is stylistically: bronze, brass and gunmetal, both leaded and unleaded, are all present.

Although Davies and Spratling (1976) had no analytical information about the alloys used; their stylistic groups stand the test of time when compositional data on metal types is examined. Thus, when the Roman and native styles are considered in conjunction with material analysis, a strong correlation is discernible. Iron Age 'curvilinear' material is all bronze; 'geometric' material is brass, and the Roman material is mixed: brass, bronze, gunmetal and leaded variations (figure 7.5). Although the composition of the alloys has already been mentioned for some artefact types, the overall pattern of its use is striking, especially when the metalworking and scrap pieces are assigned to a particular style, as can be seen in (figure 7.5). Neither leaded alloys nor gunmetals are used for the Iron Age objects in the hoard.

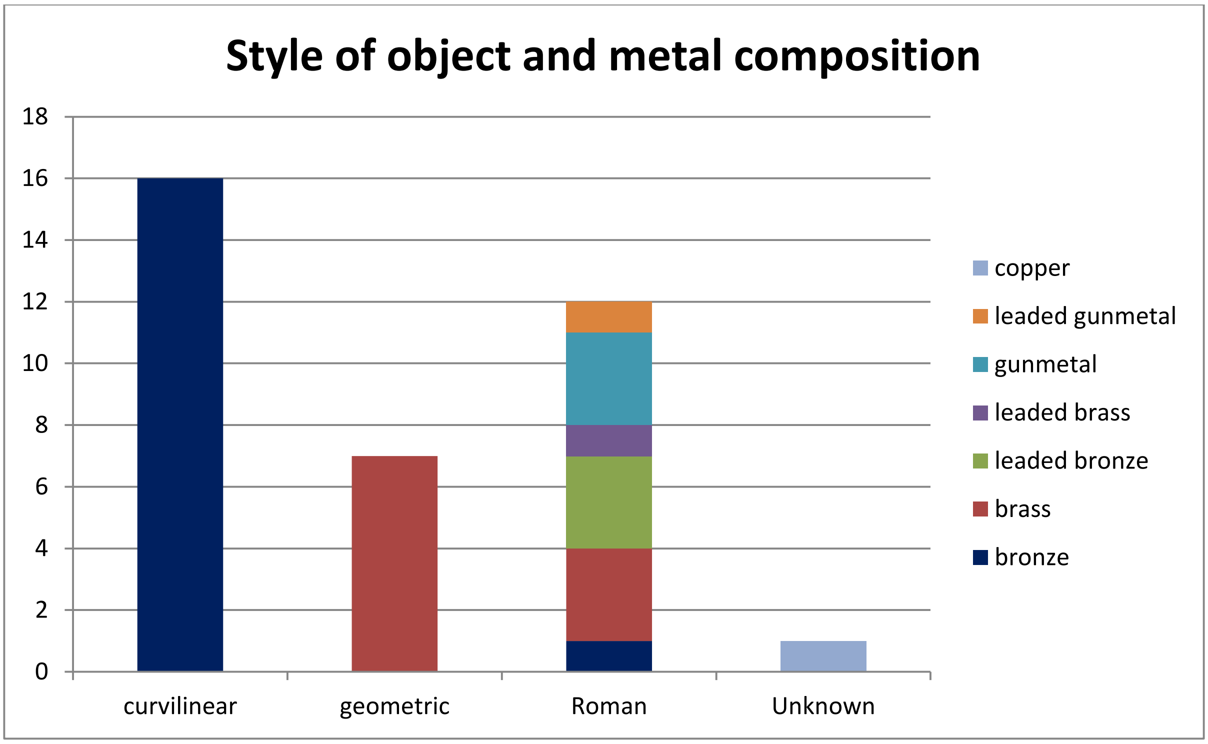


Figure 7.5: Graph showing the different metal alloys used for various object styles.

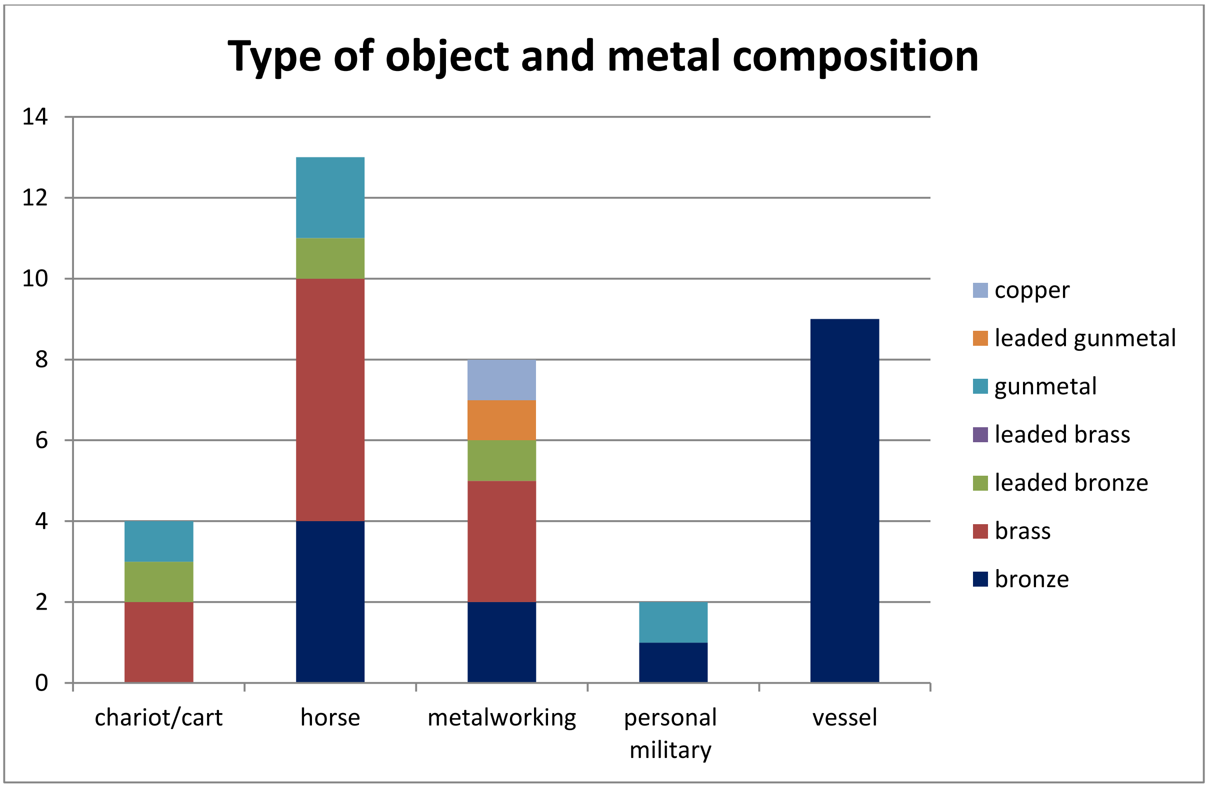


Figure 7. 6: Graph showing the different metal alloys used for various object types

When material analysis is considered in conjunction with object type, the picture appears slightly different and more complex (figure 7.6). Bronze is used for the majority of object types, and brass for three out of five; the vessel fragments, which are characteristically Iron Age in type, form and use are all bronze; whereas horse equipment which was used by both Roman and Iron Age societies shows a very mixed picture. However, chariot equipment, for which the British Iron Age peoples were famous, shows a combination of alloys which does not include bronze but does have leaded bronze, brass and gunmetal; the latter is on a Roman style object, gunmetal is rarely used for Iron Age objects. There does seem to be a notable opposition to mixing brass and bronze, prior to the established Romano-British period, and this pattern is seen in most of the hoards dated to the first century AD. As with the Santon hoard, the metal working category contains many alloy types. One of the casting jets (04.152) is leaded gunmetal and the other leaded bronze; but both (figure 7.25) are definitely alien to Iron Age metalworking techniques and materials.

Types of objects in the hoard

The objects have been divided into four basic types: those associated with horses, chariots or carts; those related to metal working or founding; those used for personal military wear, and a final group linked to feasting and drinking (figure 7.7).

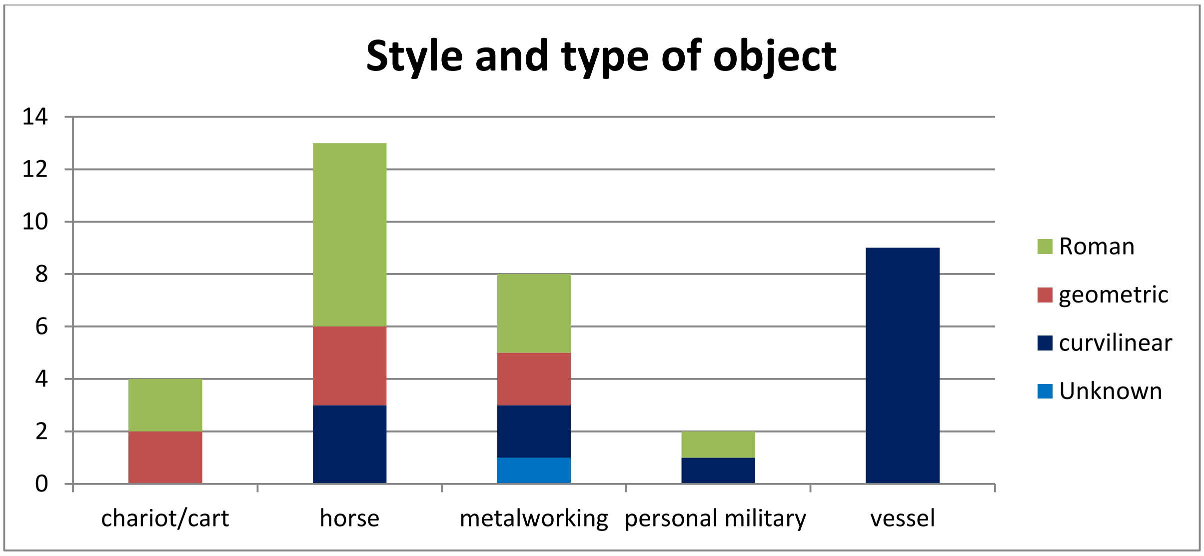


Figure 7.7: Graph showing style of object for different artefact types.

Personal military equipment

Within these categories 'personal military' equipment distinguishes this group of material from other personal decorative ornaments such as torcs, bracelets and brooches (of which there are none in this particular hoard), and other military material such as that used for horses. The group includes the helmet crest, thought to be of native origin, and a Roman buckle (figure 7.8). The buckle was probably from a soldiers belt, and Davies and Spratling cite parallels from Britain and Germany (1976, 127).

Figure 7.8: Seven Sisters helmet crest 04.145 and buckle 04.132. (Photographs: ©National Museum of Wales).

Davies and Spratling believe the helmet crest may once have contained red glass; there is a concave-sided triangle on the top of the knob which has ‘a small cup-shaped depression which presumably once held an inlay’ (Davies and Spratling 1976, 127); however there is no remaining evidence for this. The helmet crest also has very worn punched dots around each of the three bevels (figure 7.28), and three holes for attachment, a feature seen on the top of other helmets, such as the Meyrick helmet (figure 7.32).

Horse chariot/cart equipment

The horse and chariot/cart equipment form the majority of items in the hoard. These consist of terrets, strap unions, bridle-bit rings, horse pendants, bells, a phalera and an axle cap; they are present in Late Iron Age ‘curvilinear’ and ‘geometric’ forms, and as ‘Roman’ style artefacts (figure 7.9; 7.10).

Figure 7.9: Seven Sisters horse equipment in native ‘geometric ‘style, and Roman style (Photographs: ©National Museum of Wales).

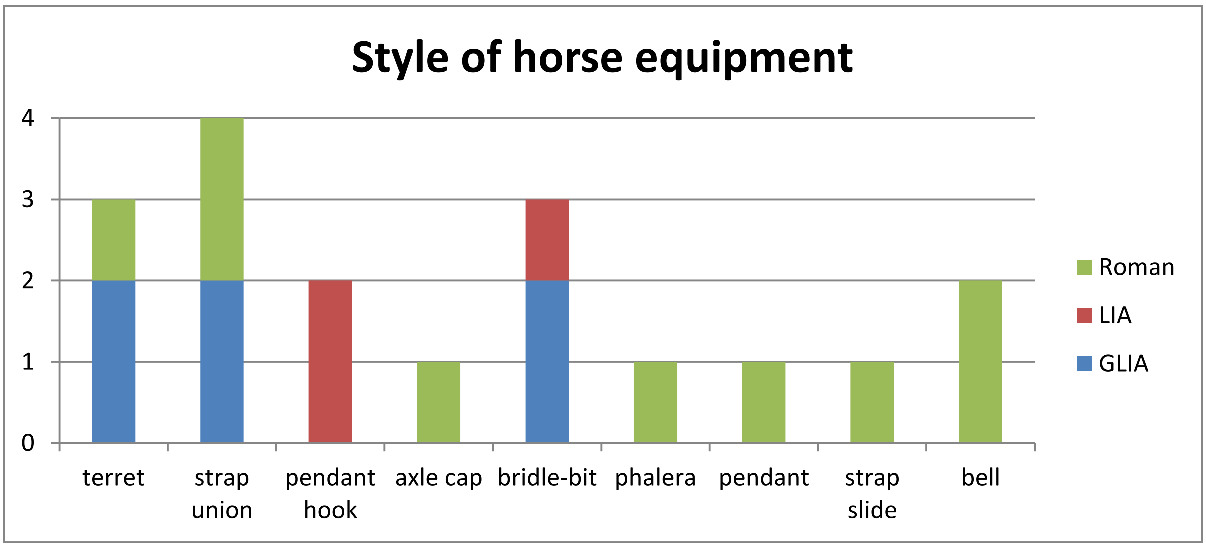


Figure 7.10: Style and type of horse chariot/cart equipment in the Seven Sisters hoard.

These objects are all made from copper alloys, but the nature of the alloy chosen is interesting and clearly grouped by style; and this reflects the types of metal used in the hoard as a whole (figure 7.11). The 'cuvilinear' Late Iron Age objects are bronze, the 'geometric Late Iron Age objects are brass and the Roman objects are made from a variety of alloy types.

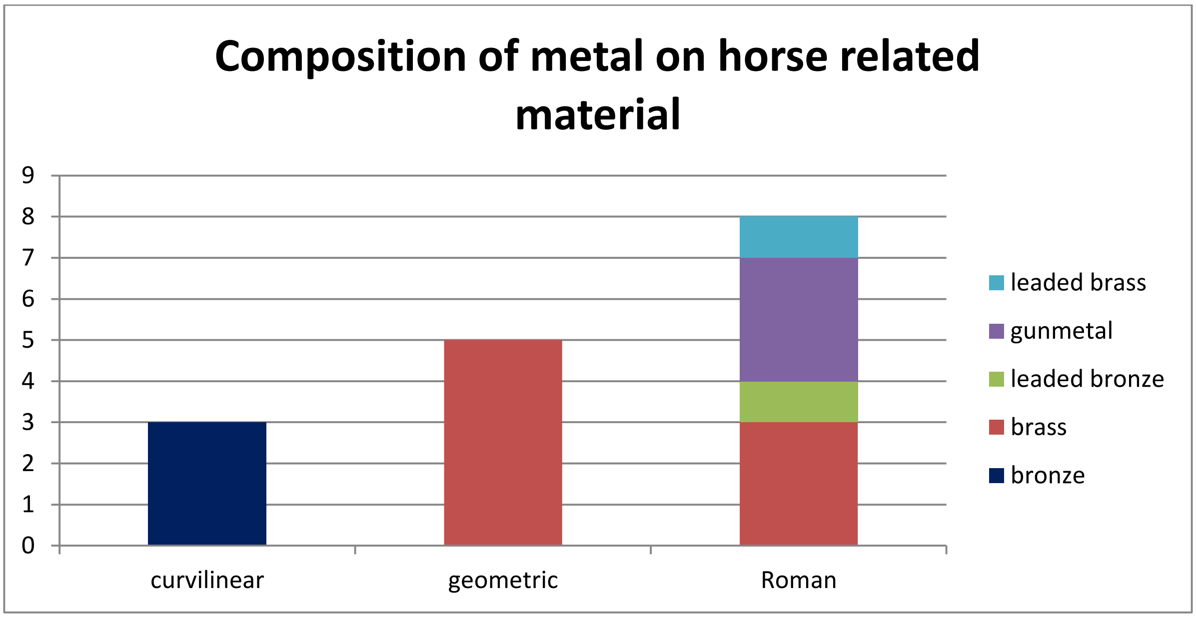


Figure 7.11: Graph showing the metal composition for different styles of object.

Curvilinear or Insular La Tène horse equipment (Late Iron Age)

The pendant (or rein) hooks (04.136 and 04.137) have been ascribed to the horse equipment category (appendix 9); their function has been debated, but it is more likely they were for use with harness gear than as fittings for armour (figure 7.12). As Palk states about this type of object 'the only function which can commonly be allotted to all 'rein hooks' is that they were suspended from straps' (Palk 1991, 83). These objects are compositionally and stylistically typical of Insular Late La Tène art; they are tin bronze and contain inlaid red glass. Each piece has been cast, and includes broad shallow voids for the inlaid decoration; the design is emphasised by inscribed lines, and some now barely discernible zigzags or hatches (figure 7.13; 7.28). Davies and Spratling (1976, 129) note these were broken but not used; and they were probably broken in antiquity.

Figure 7.12: Seven Sisters 'pendant hooks': 04.136 and 04.137. (Photographs: ©National Museum of Wales).

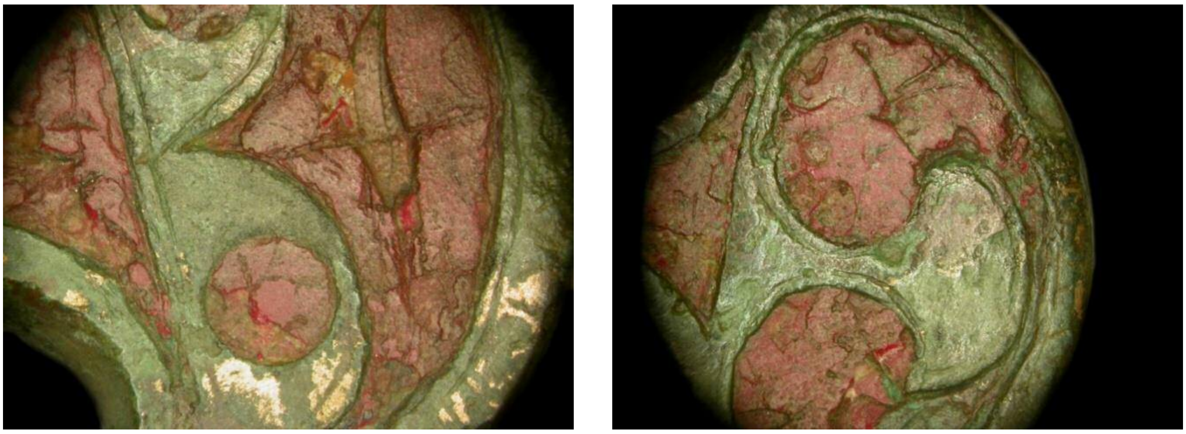


Figure 7.13: Detail of decoration on Seven Sisters 'pendant hook': 04.137 showing red glass and scribed lines (Photographs: ©National Museum of Wales).

The third object of horse equipment is probably a bridle-bit ring. It is not particularly diagnostic in form, but its size is right for such a ring from the Late Iron Age, as is its composition (figure 7.14). It has a deliberately made gap in its circumference, possibly to separate it from the rest of the bit.

Figure 7.14: Corroded plain ring 04.144 from the Seven Sisters hoard.

Geometric Late Iron Age horse equipment (GLIA)

Apart from the pendant (or trace) hooks; the Iron Age horse equipment within this hoard demonstrates a particular geometric style (figure 7.15). Both the materials used and the design of the pieces are executed in a different manner to the classic Insular Late La Tène style decoration, where shapes and voids are filled with crosshatching or inlaid glass to emphasise the motifs. Spratling and Davies refer to this newer style as 'polychromed "jewelled" …with its greater emphasis on rectilinear work (which) appears to have been a new development at about the time of the Claudian invasion' (1976, 137) These objects have cast cells of regular shape filled with enamel , which add colour, but do not contribute to the profile of the design. This is a style also seen in south east Wales in the strap union from Chepstow (Savory 1976; Taylor and Brailsford 1985), and the Boverton collar (Davis & Gwilt 2008, 167-169), and which Macgregor refers to this as 'the Silurian predilection for enamel in rectangular cells' (Macgregor 1962 34).

This apparent 'set' of horse gear (figure 7.9) is interesting in its variety; superficially all the objects look very similar; there are two fragments of (a) three-link derivative bridle-bit; two terrets and two strap unions (one of which is housed at the British Museum: 1928 1-16 1). As Davies and Spratling point out (1976, 137), a 'set' would have comprised 'a pair of bridle-bits, a pair of strap unions, and five terrets'. They feel that two sets are represented here; the first including the bridle-bit pieces, the two strap unions and one terret; the terret 04.128 is considerably more worn, leading them to suggest that this belonged to a different set.

Figure 7.15: Seven Sisters 'geometric' type artefacts; strap union 04.131; bridle-bit fragment 04.126. (Photographs: ©National Museum of Wales).

Further scrutiny of these objects shows an even more complex picture; analysis of both the enamel and metal used for the more complete bridle-bit fragment (04.125) is different to the rest of the pieces. For the metal this is not necessarily surprising as different episodes of casting would be necessary to link all the components of a three link derivative bit together; but the red enamel is clearly different in composition from all the other red enamels within this group of objects (figure 7.41), which otherwise show a relatively consistent composition (figure 7.39; 7.40); the red from 04.125 contains less aluminium, lead and manganese.

The colours used also indicate further possible differences, but this feature is complicated by the fact that only three samples were taken from each piece (except for BM 1928 1-6, which was not sampled), so the full range of colours on a single item might not have been analysed (figure 7.16).

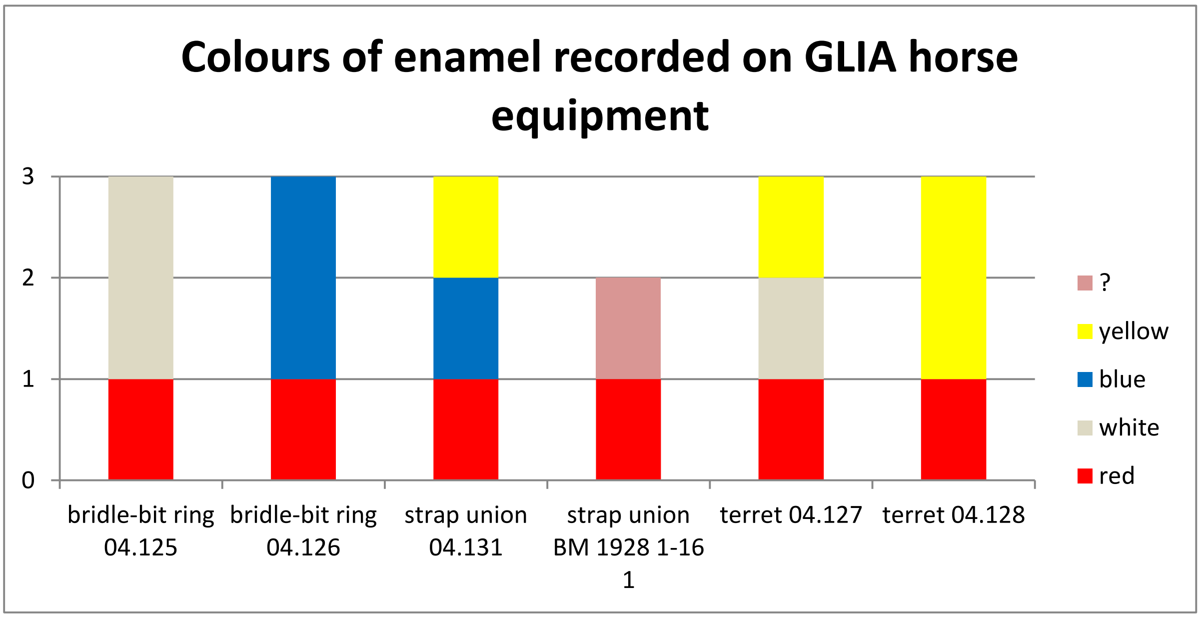


Figure 7.16: colours present in the enamels on the 'geometric' Late Iron Age material in the hoard.

When examined closely, the strap unions are not only slightly different in size; again not unexpected if they are one-off casts, but the number of cells are different (Davies and Spratling 1976, 131-2). So although all the geometric Late Iron Age horse pieces are very similar, it seems two to three different episodes of production occurred before their deposition took place; this could represent different sets, as Spratling believes (Spratling unpublished 2011), or the appropriation or subsequent manufacture of suitable pieces to make up the numbers of pieces required for use together in one set.

Roman Horse equipment

Much of the Roman horse gear is military in character (figure 7.9; 7.17), and would have been part of the horse harness equipment (strap unions 04.130 and 04.135; phalera 04.143; pendant 04.134; strap-slide 04.133); these can be paralleled by objects found on Roman military sites in Britain (Davies and Spratling 1976, 125-6, 135; Jenkins 1985; E. Chapman pers. comm.).

Figure 7.17: Seven Sisters Roman military horse equipment: strap unions 04.130 and 04.135; phalera 04.143; pendant 04.134; strap-slide 04.133. (Photographs: ©National Museum of Wales).

The other Roman style objects which are also horse related were for use on a chariot or cart. The terret fragment (04.129) has a loop at the base, which is generally characteristic of Roman examples; it has also been cast in a piece mould, and its metal composition is a leaded bronze with relatively low tin levels; not typical of Iron Age metal compositions in this or comparable hoards (figure 7.9; 7.18).

The circular object in two pieces (04.148) is interpreted here as an axle cap (see appendix 9); its diameter was originally c. 50-60mm, an appropriate size for placing on the end of an axle. Its decoration is Roman in style, echoing that of the pendant 04.134 to some extent (figure 7.18).

There are two bells (figure 7.17), which also would probably have been used as part of the horse harness; similar bells have been found on Roman military sites (Davies and Spratling 1976, 127), but are also found with Late Iron Age horse-related objects. Examples reported through the Portable Antiquities Scheme (PAS) in Wales include a toggle and bell from Defynog, Maescar (Worrel and Pearce 2012), and a bell and strap union from Maendy (Davis and Gwilt 2008, 172).

Figure 7.18: Seven Sisters Roman style horse/chariot/cart equipment: terret 04.129; axle cap 04.148, and two bells 04.147 and 04.146. (Photographs: ©National Museum of Wales).

Feasting and drinking

Feasting and drinking items form a further group. Although there are no complete objects within this category, there are five tankard handles (figure 7.19), which form the largest group to have been found together in Britain. Tankard handles often exhibit the highest quality in terms of design and manufacture.

Figure 7.19: Seven Sisters tankard handles: 04.142; 04.139; 04.140; 04.138; 04.141. (Photographs: ©National Museum of Wales).

One tankard handle from the hoard is different in both style and manufacture (04.142), closely resembling a handle from Newstead dated from a Flavian deposit (Curle 1911), and is of wrought bronze. The remaining four are larger, stronger and made from cast bronze. Two of the handles (04.140, 04.141) have traces of inlaid red glass, and all use shapes and/or inscribed lines to reveal motifs characteristic of late La Tène insular art (Davis and Gwilt 2008). As with the pendant hooks, further engraved and punched designs are used on three of the five handles (04.138; 04.140; 04.142), to emphasize shapes and features (figure 7.28).

It is probable that the tightly folded pieces of bronze sheet metal (04.156.1-3) are the remains of either drinking vessels or cauldrons; for example they could well have been part of the metal banding or covering of staved tankards, as with the examples form Langstone or Trawsfynedd (figure 7.20).

Figure 7.20: Seven Sisters folded sheet 04.156.1/2; The Langstone Tankard. (Photographs: ©National Museum of Wales).

Metal working

The third group of objects are stylistically difficult to categorise, but seem to be associated with metalworking: ingots, a weight and two casting jets (figure 7.21). It is the inclusion of these items from the hoard that have led to discussions as to whether this was a founders hoard, and whether it was deposited by Romans or native Britons (Romilly Allen 1905; Davies and Spratling 1976).

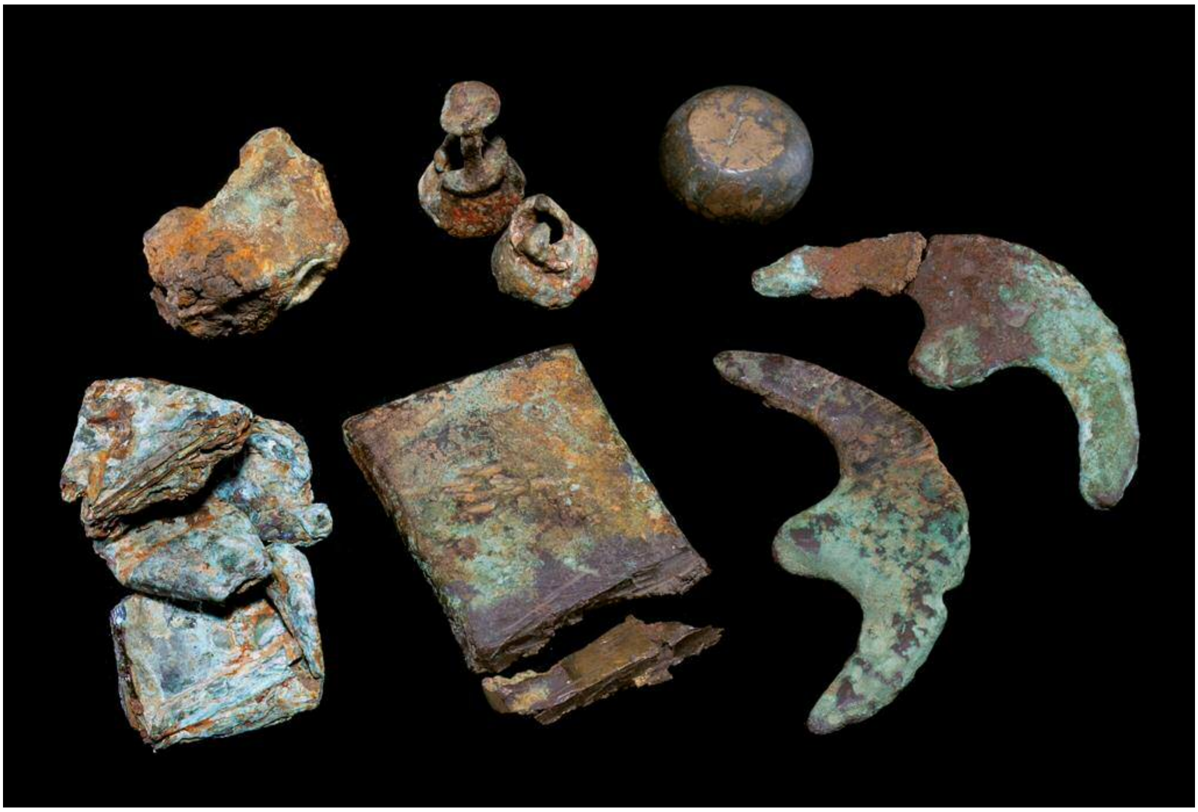


Figure 7.21: Seven Sisters metal working/scrap from the hoard. (Photographs: ©National Museum of Wales).

Analysis shows an interesting range of materials and objects for this category; and an attempt has been made to place the artefacts in one of the three stylistic categories of curvilinear, geometric or Roman objects (figure 7.22).

The three ingots are all of brass; two are pelta-shaped (04.150-151) and one is a flat oblong (04.155). The pelta-shaped ingots have a lower level of zinc than the rectangular ingot, which implies they were re-melted and cast into their final shape more often than the straight sided example. There is no evidence for Roman ingots cast into pelta shapes; and although this motif is used both in Iron Age and Roman design, a possible interpretation is that the ingots were re-cast (hence the subsequent loss of zinc) (Craddock 1978, 12; Bayley 1990, Dungworth 1997, 8) to express their indigenous nature and to emphasise their use for Late Iron Age rather than Roman objects. It is impossible to know whether the rectangular ingot was Roman or native, the zinc content of about 24 percent, although higher than the other ingots, is lower than would be produced by an efficient cementation process (Bayley 1990). This implies that the rectangular ingot was also re-cast after initial production (there is a decrease in the zinc content of brass of approximately ten percent with each episode of re-melting (Craddock 1978, 12; Bayley 1990, Dungworth 1997, 8).

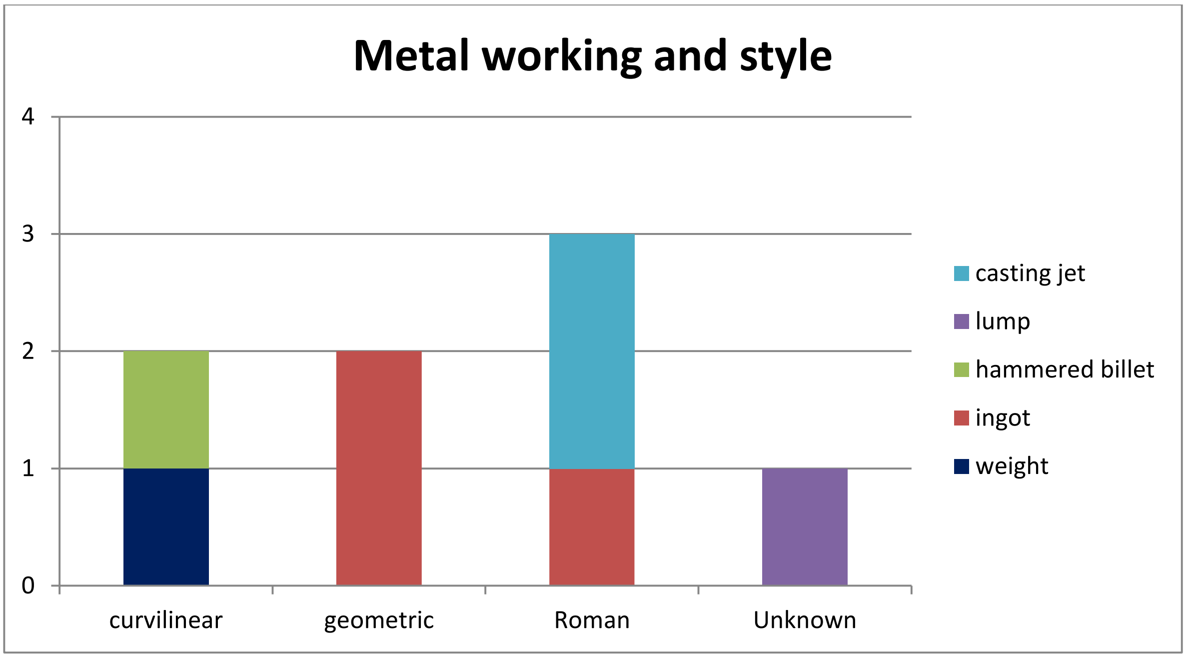


Figure 7.22: Graph showing the metal working and scrap pieces from the hoard allocated to possible styles of objects.

As with other Late Iron Age 'geometric' objects from the hoard, the ingots show a very consistent and unadulterated brass composition. Trace element analysis is inconclusive as to whether they have characteristic compositions for Iron Age as opposed to Roman brass artefacts, although the Late Iron Age material in this hoard does make up two tight compositional groups (figure 7.23).

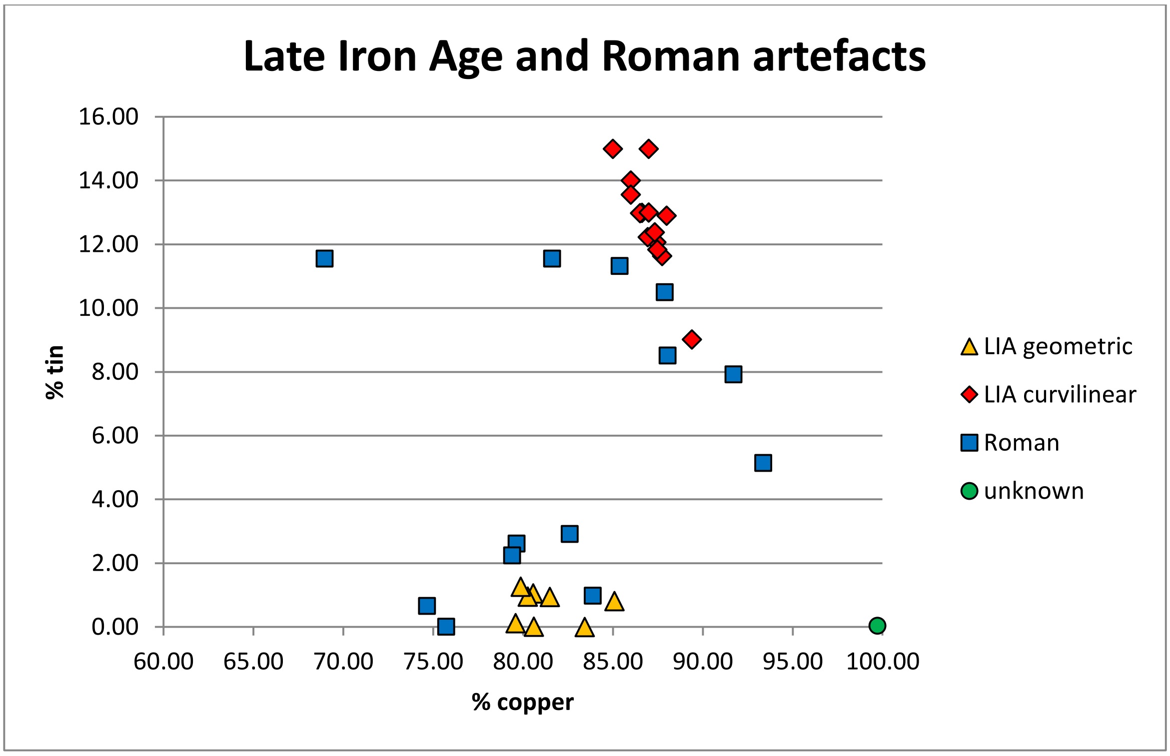


Figure 7. 23: Scatter diagram of the artefacts from the Seven Sisters hoard showing the clear division between the two types of Late Iron Age style and the consistent metallurgical content for each compared to the Roman material.

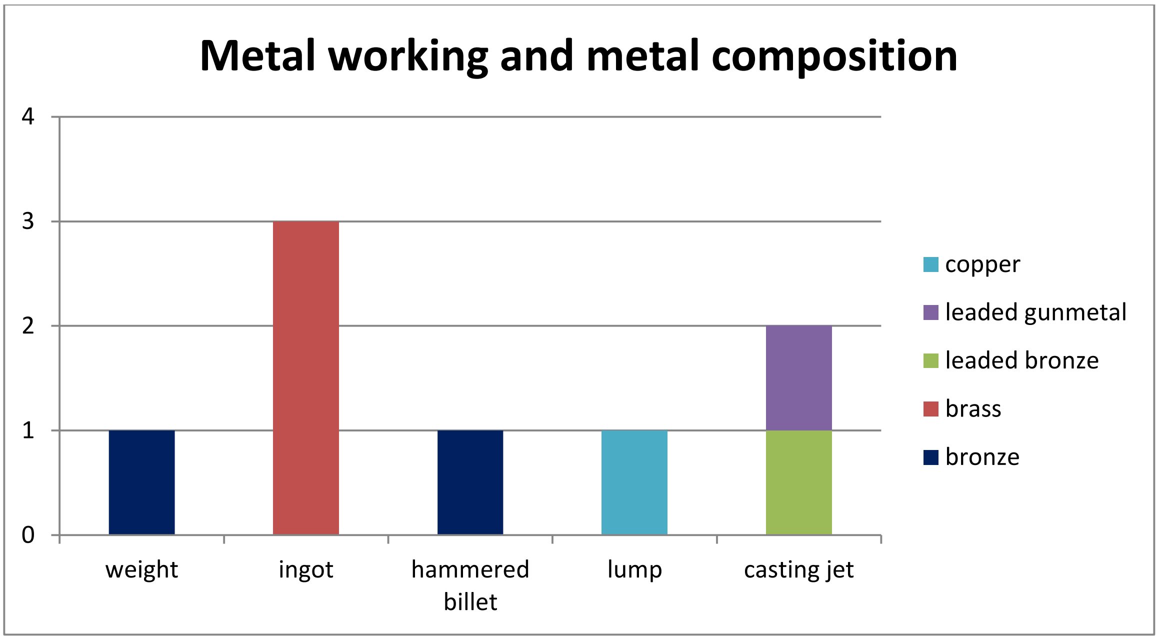


Figure 7. 24: Graph showing the metal composition of the metal working and scrap objects from the hoard.

The hammered 'billet' (04.154) looks like an incomplete cast and wrought object (figure 7.25), and is stylistically undiagnostic, but does have a bronze composition similar to the other Late Iron Age artefacts within this and other hoards. It is only the casting jets within the metalworking category which are made from alloys not used for Iron Age material from Seven Sisters.

Figure 7.25: Seven Sisters cast and wrought billet 04.154; weight 04.149; casting jets 04.152 and 04.153. (Photographs: ©National Museum of Wales).

Spratling (Wainwright and Spratling 1973, 127) identified the weight (04.149) as representing 'a standard ('Celtic pound') employed in north-western and central Europe in the late pre-Roman Iron Age and Roman period' (figure 7.25).

The two casting jets (04.152-153), which are the most evident pieces of 'scrap' in the hoard are probably Roman and show the most mixed and inconsistent composition of all the objects (figure 7.25). They appear to be used for composite piece moulds, as opposed to the investment moulds most often used in the Iron Age. In addition they both contain lead, not used with Iron Age objects within the hoard, and the occurrence of zinc in 04.152 would suggest Roman rather than prehistoric metal use.

The corroded 'lump' (04.157) is of relatively pure copper, and presumably could have been alloyed with either tin or zinc; it has no diagnostic features (figure 7.21, top left hand piece).

Decorative techniques and styles

Within the Seven Sisters hoard there is a wide range of decorative techniques applied to the metalwork including the addition of glass, enamel and niello to recesses, plus the use of inscribed and punched decoration directly to the metal surface. Tinning and silvering has been used on some of the Roman horse pieces (figure 7.26; 7.27).

The style of decoration, the form of application of additional materials and the colour of both supplementary decoration and the metal substrate allow for numerous possible combinations of effects; but again there are clear discernible patterns as to what is used in what context within the hoard. Sealing wax red glass was an Iron Age technology and was only used on bronze artefacts (figure 7.30; 7.31): for the pendant hooks (04.136-7) and the tankard handles (0.140-1); whereas 'enamelling' was a new form of inlay for Britain (figure 7.36) and was only used on the more recently attainable brass for horse harness equipment (04.125-8; 04.131 and BM 1928 1-16 1). Niello, very much associated with Roman material was applied to the silvered pendant (04.134) and one of the strap unions (04.130); the two incidences of silvering were onto the pendant (04.134) of brass and a strap union (04.135) made of brass with some tin (gunmetal); and the brass phalera (04.143) was tinned (figure 7.16). There is very little raised or repoussé decoration used in the Late Iron Age, compared to earlier periods, but chased or engraved decoration on relatively flat surfaces was much more common (for example on mirrors), and punched decoration also started to be used. Whether for Late Iron Age or Roman artefacts, this was applied to a variety of objects. Similarly cast in decoration was used either to make the form of the object elaborate, as with the geometric Late Iron Age horse gear, or to embellish it with decorative features as with some of the Roman horse fittings (figure 7.17), for example the strap union 04.135 (figure 7.26; 7.27).

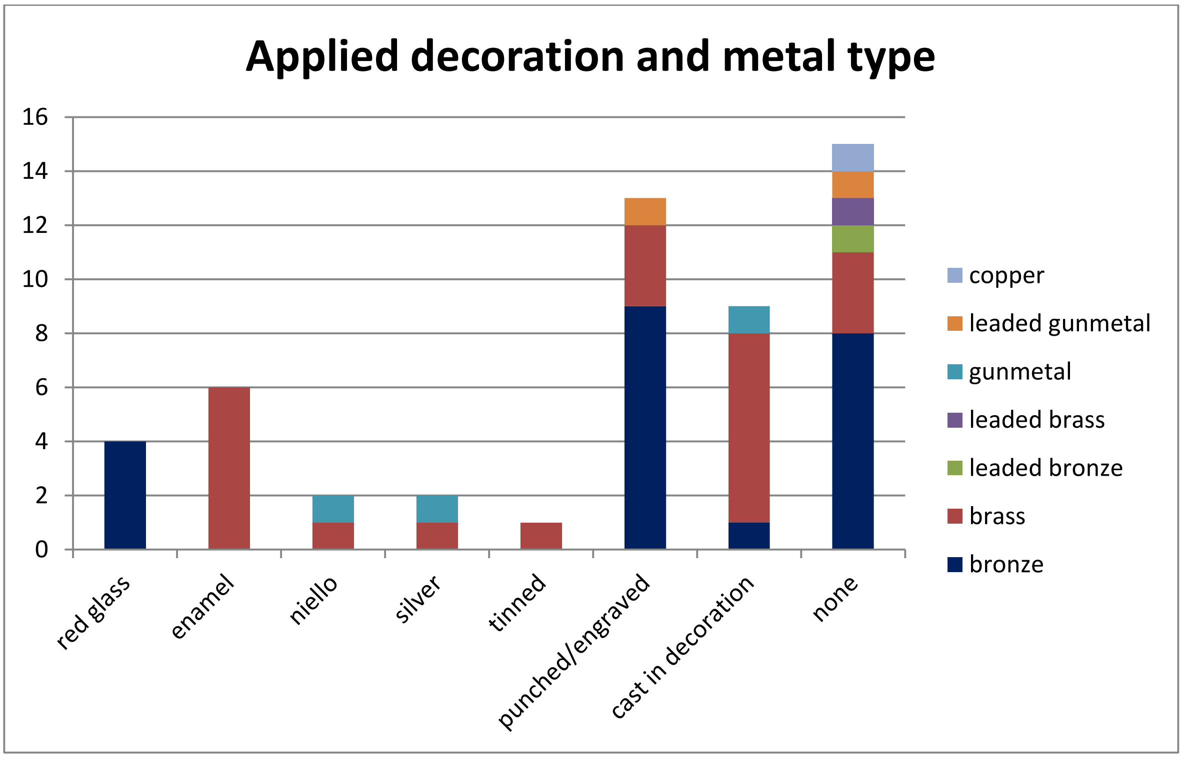


Figure 7.26: Graph showing the type and incidence of applied decoration on objects made from different alloys on all artefacts from the Seven Sisters hoard.

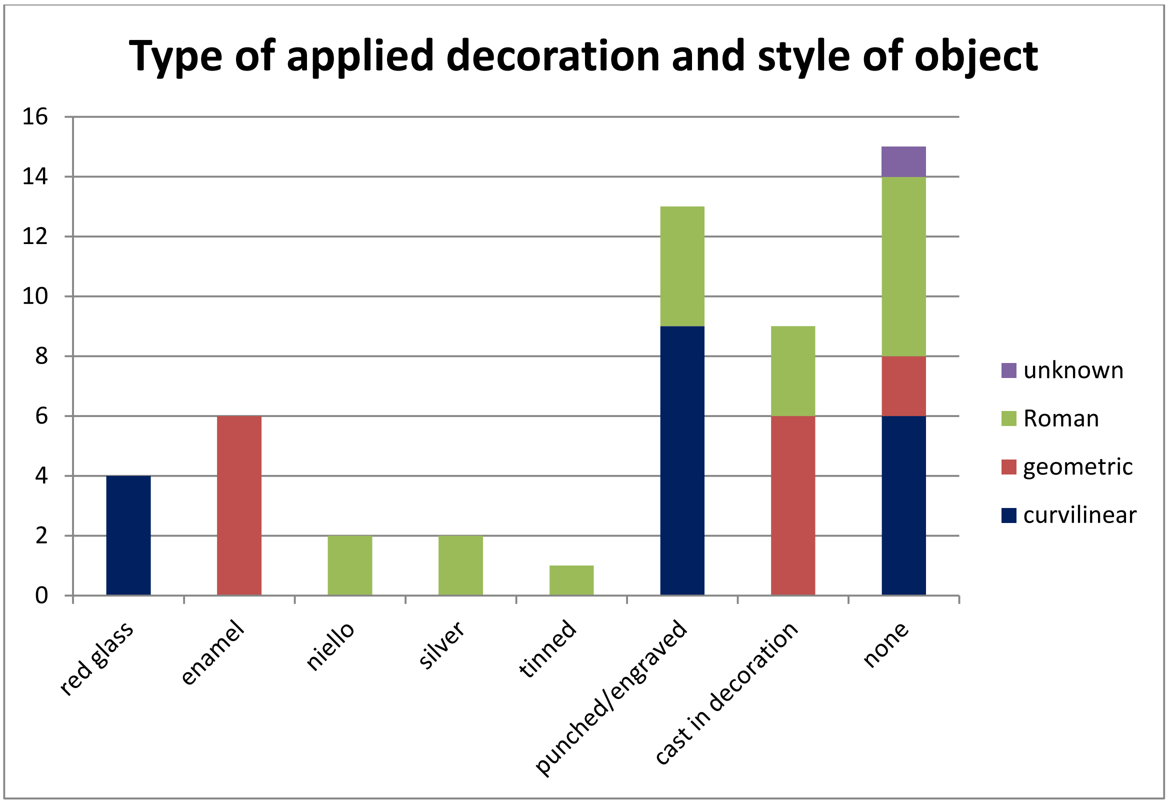


Figure 7.27: Graph showing the type of decoration applied to different styles of objects within the Seven Sisters hoard.

Engraved or punched decoration applied directly to the metal surface occurs on many artefacts decorated in the Late (curvilinear) La Tène style, including the pendant hooks, the helmet crest and some of the tankard handles (figure 7.28). However both techniques are absent on the 'geometric' objects within the hoard (although are also present on the closely paralleled strap union from Chepstow (Savory 1976)). The use of engraved lines was common on many Late Iron Age objects from Britain inlaid with red glass, where the inset decoration has a line around its edge (as seen on the pendant hooks). Both engraved and punched decoration is present on several of the pieces of Roman military equipment (figure 7.17; 7.18) and was a widely used technique during the Early Romano-British period.

Figure 7.28: Punched and scribed decoration on the helmet crest: 04.145; the pendant hook 04.137; and the tankard handle: 04.138.

Glass and enamel inlays

As stated above, Davies and Spratling's native Iron Age style artefacts, which they refer to as either 'restrained' or 'polychromed jewelled', have been separated into two stylistically distinct groups. The 'restrained' (curvilinear) group represents recognisably Late La Tène style and has flowing curvilinear patterns; shapes and voids are filled with cross-hatching or inlaid glass to emphasise the motifs. 'This technique was used to integrate recessed areas of copper alloy with inlaid opaque red glass to form complex curvilinear patterns' (Rigby in Stead 2005, 120). The native, but technically and stylistically very distinct 'polychromed 'jewelled'' group (geometric), incorporates the use of imported northern 'Barbarian' technology (Bayley pers. comm.) but uses recognisably Iron Age or 'Celtic' form and style.

Either 'red glass' or 'coloured enamels' are used to decorate the native style artefacts from the hoard. Although 'glass' and 'enamel' are similar materials, the two terms are used here to distinguish between the better-preserved, larger areas of red inlay, and the smaller areas of degraded polychrome decoration. The appearance of the inlays is very different and they were manufactured in technologically distinct ways (chapter 5). The term 'glass' is used here to denote a heat-softened inlay of sealing wax red glass, and 'enamel' as an inlay applied as crushed or ground glass within the cells, which was melted and fused to the metal substrate *in situ* (Henderson 1991) to form a cohesive block of colour. It is probably the latter method of manufacture which results in the much degraded enamels often found on Romano British artefacts.

In the 'geometric' Late Iron Age style material, the designs used are executed in a different manner. These objects have small, shallow cast cells of regular shape (rectangular, petal etc) filled with varying colours of enamel. The inset decoration is surrounded by narrow metal borders; several cells together define 'geometric and complex curvilinear designs' (Rigby unpublished). The small cells would help reduce cracking caused by the differential expansion and contraction occurring as the object was heated and cooled (Maryon 1971, 175). The enamels are much more variable in composition than the red glass and much more degraded, which makes it harder to establish their original colours; these were probably a combination of red, yellow, white and blue.

The contrast between these materials would seem to be technological as well as stylistic. Red glass was used in the Middle and Late Iron Age and polychrome enamel was technologically later. However, in Britain polychrome enamelling seems to have been adopted and used culturally for traditional Iron Age object types during the first century AD, following the Claudian invasion.

Objects containing sealing wax red (SWR) glass; methods of application

The objects from the Seven Sisters hoard with inlaid 'sealing wax' red glass use three of the most common ways of applying the glass in the Late Iron Age. One of these methods differs from those used in Middle Iron Age in many respects; the others methods have earlier antecedents. In the Middle Iron Age, this type of glass was often used more like a gem stone and attached with pins as with the Bugthorpe discs; it was also pushed into decorative metal inserts from behind, as with the Battersea shield (figure 7.29), and very occasionally made into beads (Henderson 1995).

Figure 7.29: Detail of red glass/enamel on the Battersea shield (photograph: ©Trustees of the British Museum).

The most commonly used method in the Late Iron Age was to cast large shallow shapes within the object, as with the pendant hooks (Figure 7.30). Relatively large pieces of red glass could be heat softened and pushed into these recesses (Haseloff 1991, 639; Rigby unpublished); the glass could then be ground down to lie flush with the metal, and also to remove any discoloured or oxidised glass from the surface; it was then polished down to obtain its intense opaque bright red colour.

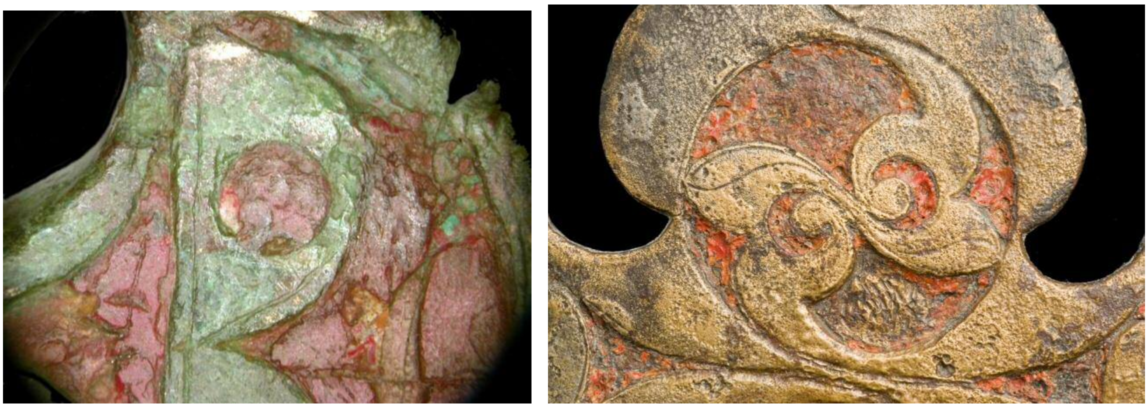


Figure 7.30: Pendant hook 04.137 and strap union from Allt Wen; both have shallow cast in recesses which have been roughened and slightly undercut to hold the red glass more securely in position (Photographs: ©National Museum of Wales).

A second method of application can be seen in the tankard handle 04.140: here the metal has voids rather than recesses, and heat softened red glass was probably pushed in from the reverse side of the object, and then ground and polished on the obverse as with the shallow inlays. This method of application is also seen on a small dome from Whitton, and on two of the three knobs on the Pentyrch terret (figure 7.31). This is similar to the method used earlier in the Iron Age to apply red glass into some of the decorative elements of the Battersea shield (figure 7.29).

Figure 7.31: Tankard handle (04.140); the Whitton knob showing the voids into which the red glass was pressed; one of the knobs from the Pentyrch terret made in the same way but with the red glass more intact.

The third way of inlaying glass also appears to stem from earlier Iron Age origins, and was applied onto a carefully cast stud with regular crossed recessed; this was probably the method used to decorate similar studs present on the hilt of the Kirkburn sword. Within the Seven Sisters hoard this decoration can be seen on the applied rivet heads of the tankard handle (04.141), (figure 7.32). There is very little glass remaining, but microphotographs and SEM analysis show that it was once applied to the depressed areas within the cast cross-hatching (figure 3.77). Red glass has also been noticed on other similar studs, for example those on the Meyrick helmet (figure 7.32; 7.34).

Figure 7.32: Seven Sisters tankard handle 04.141, plus replica (Photographs: ©National Museum of Wales). The Meyrick helmet 1872,1213.2 (Photograph: ©Trustees of the British Museum).

The very evenly cast cross-hatched domed stud on the Seven Sisters tankard handle, and on others such as the Meyrick helmet are similar. It is very likely that heat-softened glass was applied on to these studs then polished down to reveal a red and gold cross-checked pattern. It has been argued that the cross-hatching was to roughen the surface to help adhere the glass, however, this seems unlikely, as it is radically different from other roughened surfaces (figure 7.30), and has been very carefully and evenly made. Not much of the glass remains *in situ* partly due to the difficulty of achieving a good bond between the thin strips of glass and the narrow channels within the cross hatched lines in the metal.

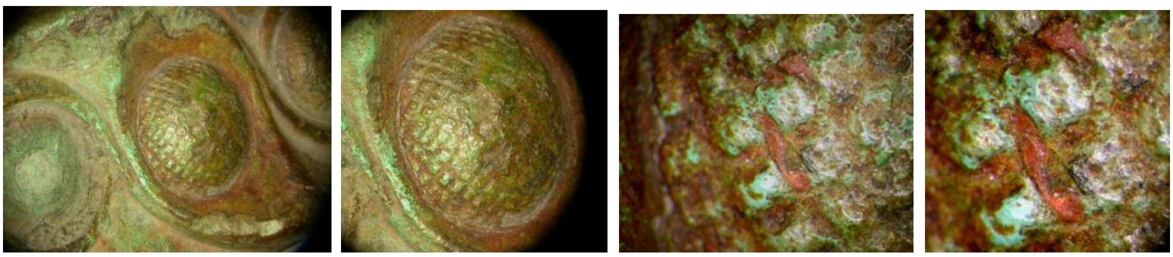


Figure 7.33: Detail of the central stud on the Seven Sisters tankard handle 04.141. Red glass is visible within the recessed areas of the cross-hatching.

Figure 7.34: Detail showing cross-hatched studs on the peak of the Meyrick helmet 1872,1213.2, with small amounts of red glass remaining *in situ*; plus drawing of side stud (see figure 7.32 above) (©Trustees of the British Museum; original drawing coloured by author).

This decoration is later echoed on many disc like parts of artefacts such as in the enamelled decorated roundels inserted into the massive armlets from north east Scotland, (figure 7.35), or the head of a linchpin from Staffordshire (PAS wmid-947693_3 Hatherton).

Figure 7.35: Castle Newe massive armlet (photographs: ©Trustees of the British Museum), and Hatherton linch pin with derived red and yellow checked decoration; generally more prevalent in northern and western Britain. (photograph: https://finds.org.uk/database/images/index/objecttype/LINCH+PIN/sort/broadperiod/licenseAcronym/BY-SA)

Objects containing polychrome enamel

The polychrome enamel inlaid into the 'geometric' style artefacts was very degraded and largely missing, but SEM analysis helped determine their original compositions and colours (figure 7.36).

Figure 7.36: Seven Sisters: detail of the bridle-bit fragment 04.126, and the strap union 04.131.

Although the Seven Sisters sealing wax red glass is very similar to the composition of other sealing wax style Late Iron Age glass from Britain; the red enamel is more diverse compositionally, and is difficult to classify (figure 7.37). Elemental analysis shows some relation to that of sealing red wax glass as well as to Roman tesserae and Romano-British enamels, but does not equate well to any of these. The Seven Sisters enamels could represent an early local attempt at producing polychrome colours using available knowledge and materials.

The red enamel from the Seven Sisters 'geometric' pieces has higher lead oxide and antimony trioxide contents than most Roman and Romano British glass and enamel (figure 7.41), and these levels are much closer to that seen in sealing wax red glass. However, copper oxide, which is the other significant compound for forming sealing wax red glass (chapter 5), is relatively low in the Seven Sisters enamel (figure 7.37). In addition, other oxides, such as potash, lime, alumina and iron, are also present in the geometric 'enamel' in very different quantities to the Iron Age red glass (figure 7.37; 7.38; 7.40).

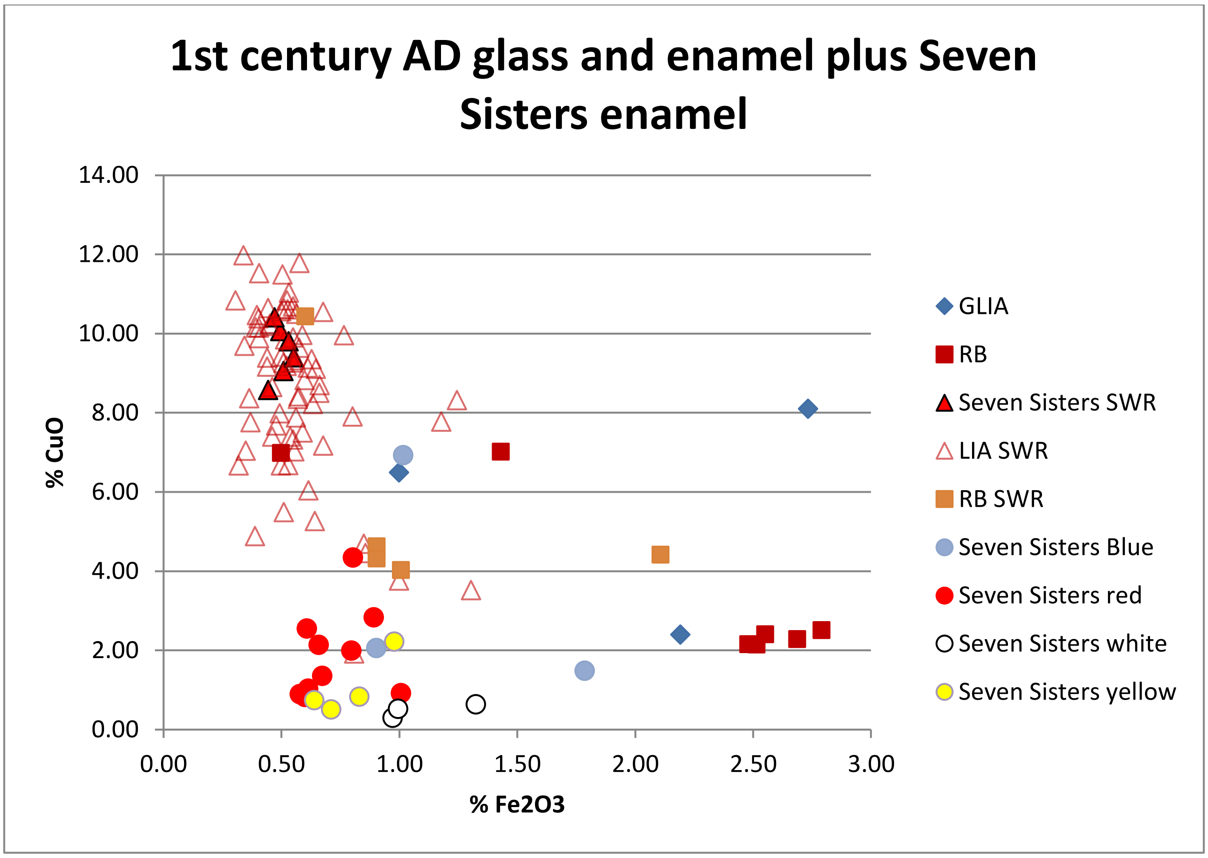


Figure 7.37: Scatter diagram of iron oxide and copper oxide. The red enamel contains considerably less copper (average c.1.9%) than the majority of the sealing wax red glass from Britain (average c.9%) (For sources: see appendix 3).[2]

[2] RB=Romano-British; LIA =Late Iron Age; GLIA=Geometric Late Iron Age; SWR=Sealing wax red; RB SWR= Romano-British sealing wax red.

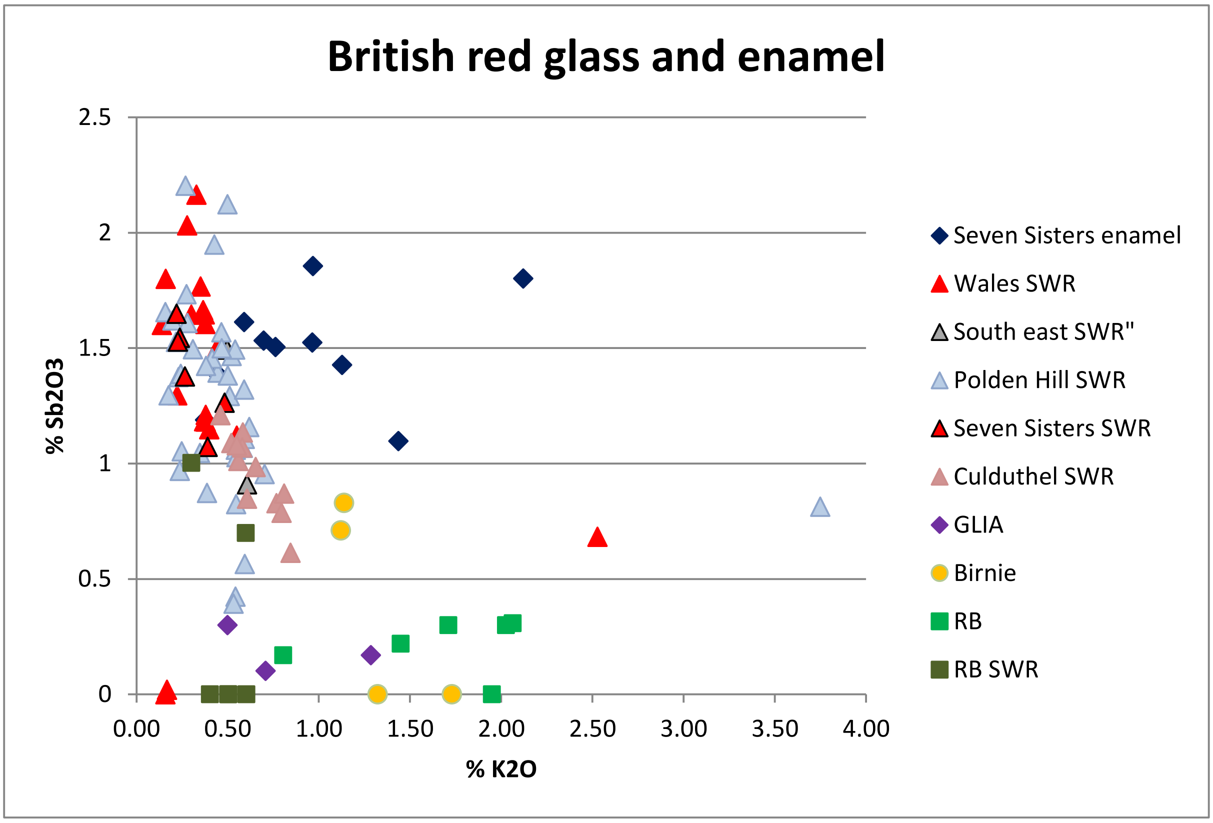


Figure 7.38: Scatter diagram showing sealing wax red from a number of British sites, plus various other types of red glass from Britain. Seven Sisters red enamel forms a separate group; although it contains similar quantities of antimony trioxide, the potash levels are generally higher; this could be the result of putting ash in the molten glass to help maintain reducing conditions (Freestone pers. comm.) (For sources: see appendix 3).

The scatter diagrams shed some interesting light on the manufacture of coloured glass, and red glass in particular; as in chapter 5, it can be seen that for alumina and lime Mediterranean Near East and Roman/Italian glass form a distinct group from the geographically distant and (mostly) chronologically later, Romano-British glass (figure 7.39). In this scatter diagram the 'enamel' from the Seven Sisters hoard fits much better into the Romano-British vessel glass group, though is slightly more dispersed. The Late Iron Age sealing wax red glass from Britain tends to coincide much more with the Mediterranean Near East and Roman glass, and the Roman yellow tesserae with higher alumina content (figure 7.39; 7.40).

However, as mentioned above, when quantities of lead and antimony oxides added to the red enamel are compared to Late Iron Age red glass, the picture is very different (figure 7.41). For these two oxides none of the red Seven Sisters enamel overlaps with Romano-British red enamels, or Mediterranean tesserae; but do overlap with the Late Iron Age red glass. Both Lead and antimony are important additions for the growth of cuprite crystals, which typify sealing wax red glass, and which needs to be formed within a reducing atmosphere. Antimony is especially associated with this type of glass in the Late Iron Age in Britain, but not for continental La Tène glass, and there are very few examples of sealing wax red glass with this composition from the Mediterranean area (See chapter 5).

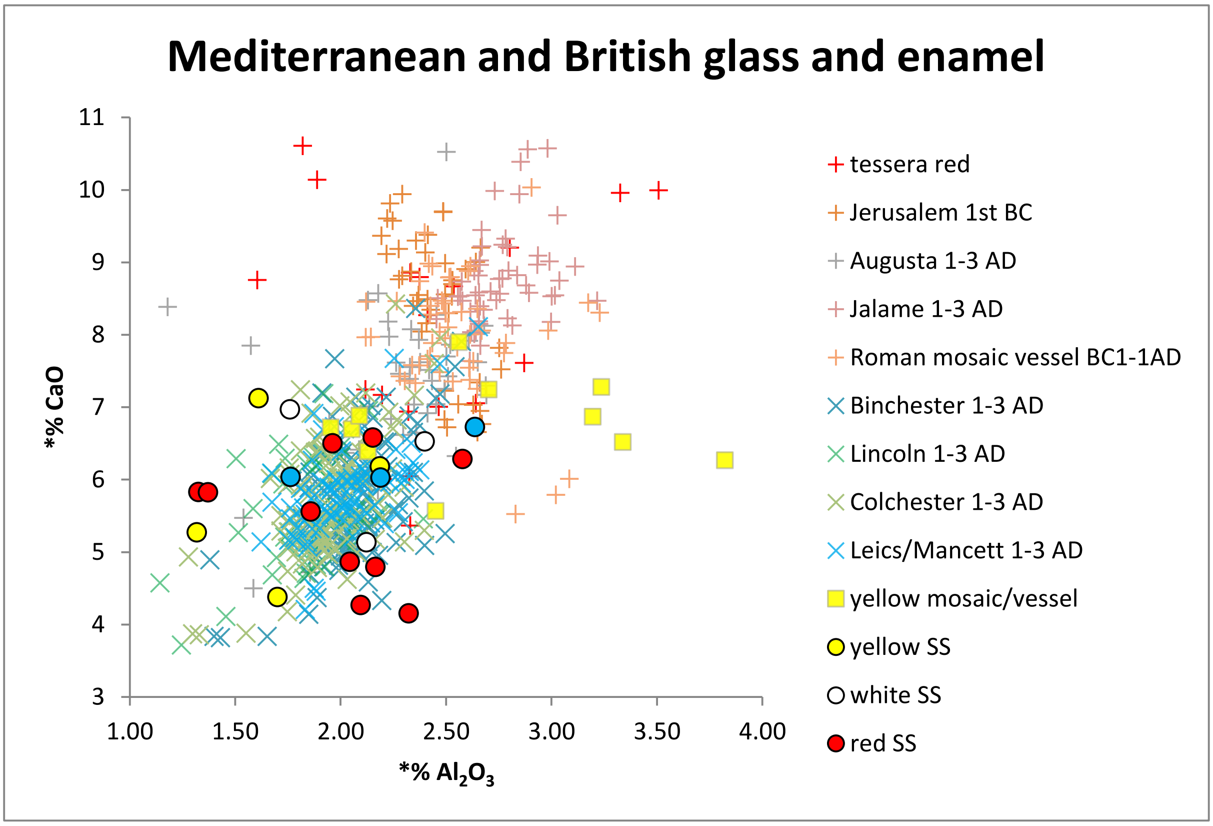


Figure 7. 39: Scatter diagram for alumina and lime. Glass from the Mediterranean Near East and Italy (+) form a distinct group from Romano- British vessel glass (X). Here Seven Sisters enamels appear closer in composition to Romano-British glass. (For sources: see appendix 3).

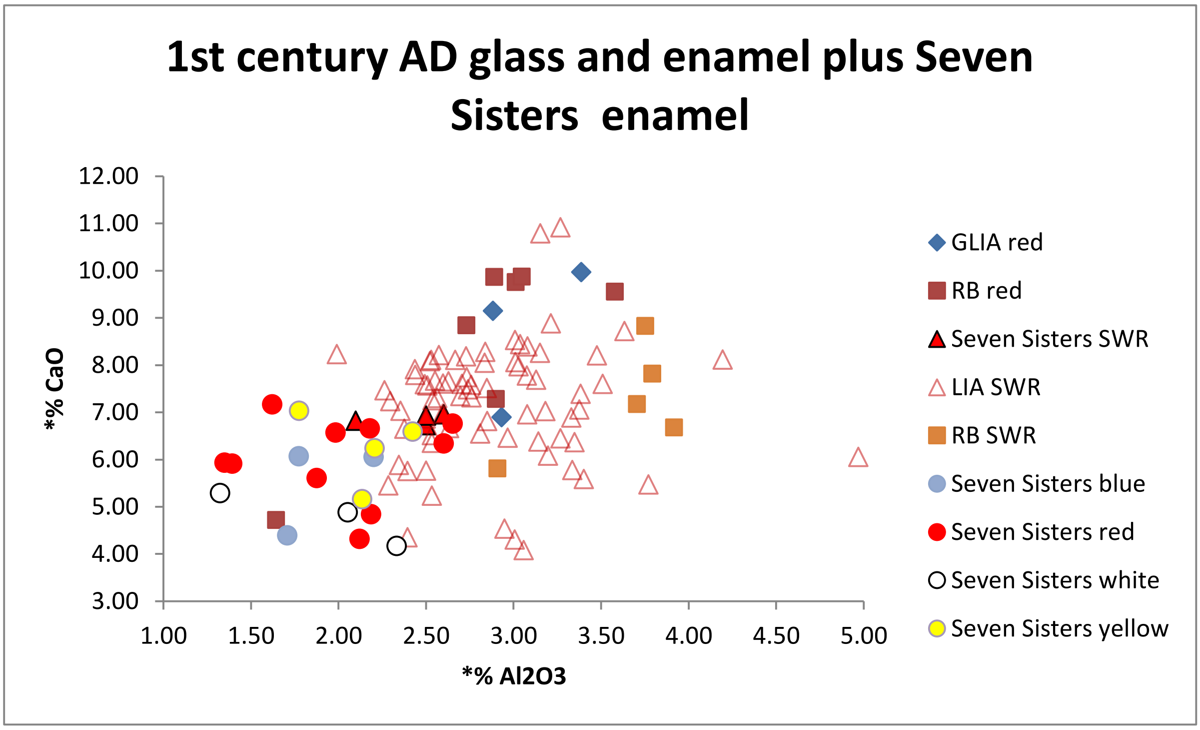


Figure 7. 40: Scatter diagram of alumina and lime showing the distinction between the majority of Late Iron Age sealing wax red glass and the Seven Sisters coloured enamels. Romano-British red enamel and Romano-British sealing wax red are varied in composition. (For sources: see appendix 3).

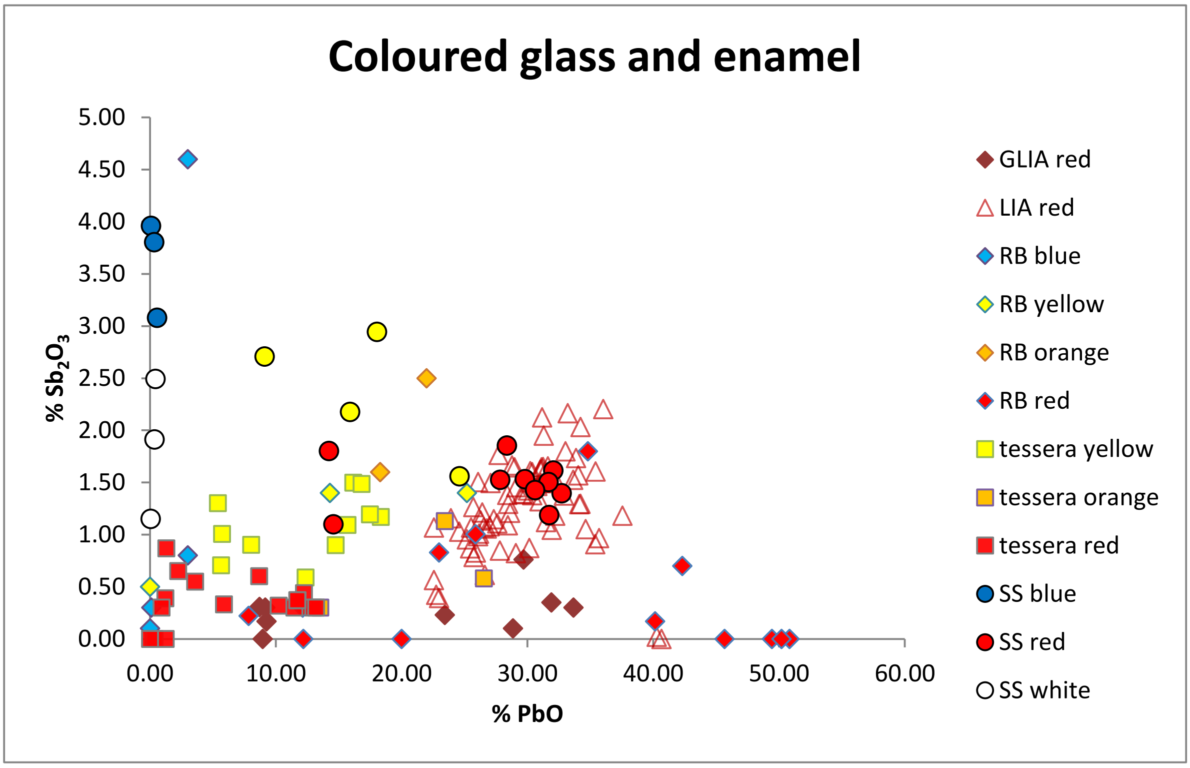
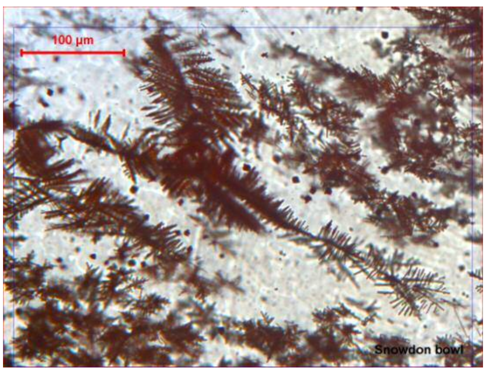


Figure 7. 41: Scatter diagram of lead oxide versus antimony trioxide; the majority of the Seven Sisters red enamel coincides with the Late Iron Age British glass. The blue and white form a separate group along the Y axis. (For sources: see appendix 3).

Although the lead and antimony oxide levels are similar for both the Late Iron Age red glass and the Seven Sisters red enamel, their micro-structures are very different (figure 7.42); the Seven Sisters red enamel has no cuprite dendrites, but instead contains sub-micron particles of copper/oxide (Barber *et al.* 2009), as with the Roman and much of the Romano-British red glass (chapter 5). The difference in composition between the Roman red glasses and the Seven Sisters red enamel, and the similarity of the Seven Sisters enamel and the Sealing wax red glass implies that some of the ingredients used to produce Late Iron Age sealing wax red glass were added in Britain. This in turn could provide further evidence that in the Late Iron Age, glass imported from the Mediterranean or Near East was coloured at some centres within Britain rather than on the continent, and the distinct composition involving the consistent use of antimony was a British adoption and/or adaption.



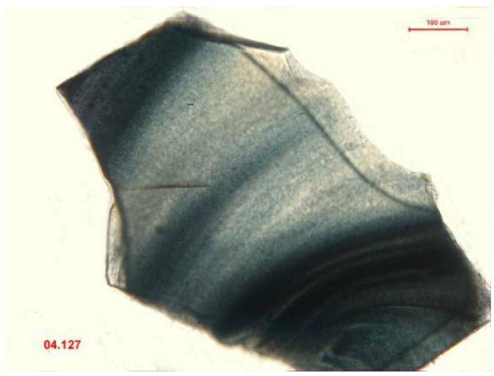


Figure 7. 42: Microscope images taken under polarising light showing cuprite dendrites in Late Iron Age sealing wax red glass, and sub-micron particles of cuprite/copper in the Seven Sisters red enamel. Both scale bars = 100µm.

As the use of technology and fashion for the production of enamelled objects spread within Britain, the strict composition and manner of manufacture of coloured glass was less strongly adhered to; it adopted some Roman techniques, but also developed local methods of producing such goods. Bateson and Hedges (1975) have noted idiosyncratic quantities of elements within Romano-British enamels such as tin, lead and antimony, which are present irrespective of their use as colourants, and suggest the recipes of individual craftsmen or workshops might have been used. This is a practice that is also later reflected in the use of more mixed metal alloys for the manufacture of metal items in the Romano-British period.

For the other polychrome enamels comparative data is more sparse; but for the scatter diagram (figure 7.41), it can be seen that quantities are variable for the Romano-British examples, but the basic colourants are similar: the yellow enamel has a high lead oxide content (average 17 %) and is coloured by lead antimonite; the white enamel has a low lead oxide (average 0.3 %) and is coloured by calcium antimonate. The blue enamel contains 1-6% copper oxide, and the colour also seems to be lightened and opacified by the use of calcium antimonate.

A further distinctive characteristic of the enamel used in the native 'geometric' artefacts from the Seven Sisters hoard, is their zinc content. Iron Age red glass and Romano-British enamels show virtually no zinc present, whereas the Seven Sisters enamels show a significant amount. There are two possibilities for this; the first is that the objects from the hoard were burnt when they were buried (and the condition of some of the inlays suggests this); if that were the case, the zinc might have volatilised and seeped into the glass matrix; enamel on other brass substrates do not usually show zinc in their composition (Bateson & Hedges 1975; Henderson 1989), although there are a couple of exceptions such as the Fulking terret (Suffolk), containing 1.4% (Freestone pers. comm.) and a Roman red mosaic wall tessera from Pompeii containing 1.7percent zinc (Van der Werf *et al.*) Much Roman red glass contains a small amount of zinc (less than one percent), which is probably due to the use of brass as a means of adding the copper as the colourant (tin is also sometimes present). The other possibility, considering the quantities, is that the addition of zinc to these enamels may be due to special properties associated with zinc ores. Their seemingly alchemical nature in transforming copper to gold-coloured brass could have influenced its addition to the enamels where it apparently serves little practical purpose.

Colour and style

Both chemical analysis and stylistic interpretations suggest there are two distinct Late Iron Age traditions occurring in south east Wales in the mid first century AD: 'curvilinear' and 'geometric'. Both styles are close chronologically and both are different to contemporary Roman material.

The first of these, the 'curvilinear' La Tène style, consists of artefacts made from bronze using the lost wax technique. They are sometimes decorated with inlays of sealing wax red glass; the large filled recesses or voids in the metal are integral to the 'curvilinear' style design, (as with the earlier use of basket hatching to enhance the motifs). The high lead content of the red glass almost certainly made it easier to soften and inlay these relatively large areas; it would be technologically far more taxing to fill these voids or recesses with ground glass heated *in situ*.

The largely restricted use of red (and occasionally yellow coloured glass, see chapter 5), but not blue or white, for more traditionally designed 'curvilinear' La Tène artefacts, seems significant to a greater extent at this period in regions outside the more rapidly Romanised south east of England.

There is frequent use of red (and occasionally yellow) glass on horse equipment, and on similarly 'curvilinear' styled artefacts such as tankard handles, mounts, bowls, and even figurines. Yellow glass seems to be acceptable in these contexts to some degree; as with the Hambledon, Buckinghamshire strap-union (Haseloff 1991 642), the recent find of a massive strap union from Maendy in South Wales (Davis and Gwilt 2008, 172), and the massive armlets from north east Scotland). In south east England, the correlations shown between type of metal, colour of decoration and style of ornament are not so clear-cut. For example, the 'curvilinear' style 'Suffolk'/Lakenheath terret (Foster 2002) has blue glass used with red enamel, as does the harness brooch from Folly Lane (Foster in Niblett 1999), this object also uses a brass substrate for a 'curvilinear' style artefact. Other colours of inlay were also used; for example the Westhall quadrilobed harness mounts have a pale coloured inlay (Bateson 1981, 18). It therefore appears that the coloured inlay and the metal alloy used for these artefacts from southeast England were not selected to such rigid formulae. This region of England was using a combination of native and imported Roman technology soon after the invasion (e.g. the bridle-bit from Folly Lane (Foster in Niblett 1999), and there appears to be a more chaotic and less structured approach to the use of these different styles and technologies. Perhaps this reflects the more immediate upheaval produced by rapid Romanisation compared to the lengthy campaigning and formalised cultural resistance reflected in artefact technology further north and west.

It is also possible that the relatively rigid use of colour is a reference to the past where the restricted and symbolic use of colours was practised more rigorously (e.g. symbolism equated with the martial/bloody and sometimes masculine nature of red as well as possible dynamic properties and magical powers (Giles 2008; Jones and Macgregor 2002; Young 2006). This practice then retained more significance in frontier zones.

Of the four main colours of glass used in the Iron Age in Britain (red, yellow, blue and white), blue and white are those used least for inlays, and are notable for their absence on most martial and feasting gear decorated in the 'curvilinear' La Tène style. Blue has possible gender connotations: colour symbolism is discussed in more detail by Mel Giles (2008), but it is interesting to note that in the Yorkshire burials blue glass beads were exclusively buried with women (Fitzpatrick 2007; Giles 2008). It is also worth noting the extensive use of white, yellow, colourless and blue glass, but hardly ever red, for Iron Age beads, for example those from Meare and Glastonbury (Henderson 1987, 1995).

There is also a technologically limiting factor for the application of different coloured inlays: both red and yellow glasses are heavily leaded, and are therefore more easily softened, cut and applied into large irregular shaped areas. Neither the blue nor white Iron Age glass would have these properties; they were more likely to be applied as coloured dots. Where blue glass is used, this is generally as small fragments, which often seem to be adhered down to the substrate with the use of the softened red glass (Spratling 1972, 274). It is not until enamelling techniques using powdered glass were introduced that these colours could be applied in more controlled ways to shaped champlevé recesses. Even then, larger cells appear to have been relatively difficult to 'enamel'.

The importance of the colour of the metal substrate should also be considered. The 'geometric' style objects in the Seven Sisters hoard are made from brass, which involved a very different technique of production, i.e. the cementation process (Bayley 1990). Brass looks quite distinct from bronze and possesses a colour and sheen only previously seen on gold metal itself (figure 7.43). The adoption of this gold coloured metal is notable when gold artefacts (non-coins) were uncommon in the west of

Britain in the Iron Age, and in particular in Wales, apart from the odd coin imported from England and the border area (for possible Iron Age gold artefacts from Wales see Gwilt 2007). It is likely that imports of gold from Ireland to Wales had ceased by the end of the Bronze Age (Northover 1995, 529), and most gold entering Britain from the continent was to the south east of Britain, becoming relatively scarce further north and west of this region (Beswick *et al.* 1990, 27).

Figure 7. 43: The geometric brass objects as they appear now, and replicas showing how the brass and enamel may have looked in the Late Iron Age. (Photographs: ©National Museum of Wales).

Choice and use of metal alloys

The metal composition of prestigious Late Iron Age 'curvilinear' style artefacts from the west and north of Britain in the mid to late first century AD was bronze, without zinc or lead. This seems to have been closely and deliberately adhered to, as was the type of artefact manufactured and the type of design used. The radical change in colour and design used for the 'geometric' style objects is striking, especially as the artefact types remain the same (horse harness equipment) and there is a similar use of a relatively pure and consistent metallurgical composition, though in this case for brass.

The implication is that those commissioning or manufacturing both these styles of artefacts were innovative and well connected, and able to access both the technology and the materials needed. There are several possibilities to consider for their apparent contemporaneity: these 'geometric' style objects were possibly being commissioned by competing Iron Age groups, tapping into new resources and technologies and literally showing their colours. Alternatively there were fluctuations and changes in the availability and production of materials at this time, for example there may have been periods when obtaining tin from Devon or Cornwall were especially difficult. Metal workers were accessing and working with different materials, but those using the objects still wished newly styled and coloured items to deliver explicit messages regarding alliances and status through artefact type. Both the old and the new styles were circulating and deposited together during the mid to late first century AD and it is likely that Late La Tène 'curvilinear' style material in this hoard was made at a similar time to the 'geometric' style. Davies and Spratling (1976) note that the pendant hooks were broken but not used, implying the contemporary manufacture of both 'native' styles of object.

Despite the colour of the metal, artefacts manufactured from pure brass were not normally used for high status (non-brooch) personal ornament in the first century AD, i.e. torcs and collars, (for example Dinnington (Northover in Beswick 1990, 22), Boverton (Davis & Gwilt 2008, 167-169) and Tre'r Ceiri (Savory 1971, 67)); these are brass or bronze, but the metal is not so pure. They tend to contain tin and zinc, as well as some lead. The select and functional quality of decorated Late Iron Age artefacts for horses and feasting and drinking, and the skill used for their manufacture and design imply these bronze and brass objects were valued both for their practical attributes, and for their importance and worth as items of communal display, rather than as objects of personal ornament or the wealth to acquire precious metals.

The copper alloys used for Iron Age horse harness equipment in the Seven Sisters hoard echoes that of the larger hoard from Stanwick/Melsonby; where both show a similar pattern in the use of either bronze or brass for certain types and styles of artefact (Dungworth 1996). There are four distinct 'sets' (A-D), three are brass and one is bronze. The association of metal alloy with the type of glass or enamel inlay is also maintained in the Stanwick/Melsonby hoard; only the harness set D, which is bronze rather than brass, appears to have inlaid sealing wax red glass.

There are also some 'non-hoarded' artefacts from the same period illustrating these traits such as the Folly Lane harness brooch and bridle-bit (Northover in Niblett 1999 142-3), and the Saham Toney strap union (Northover in Beswick 1990, 22). Interestingly, these brass artefacts are inlaid with polychrome glass/enamel. There does appear to be a discernible pattern for carefully chosen object and material use for Late Iron Age styled material, especially the type of artefact deposited within hoards.

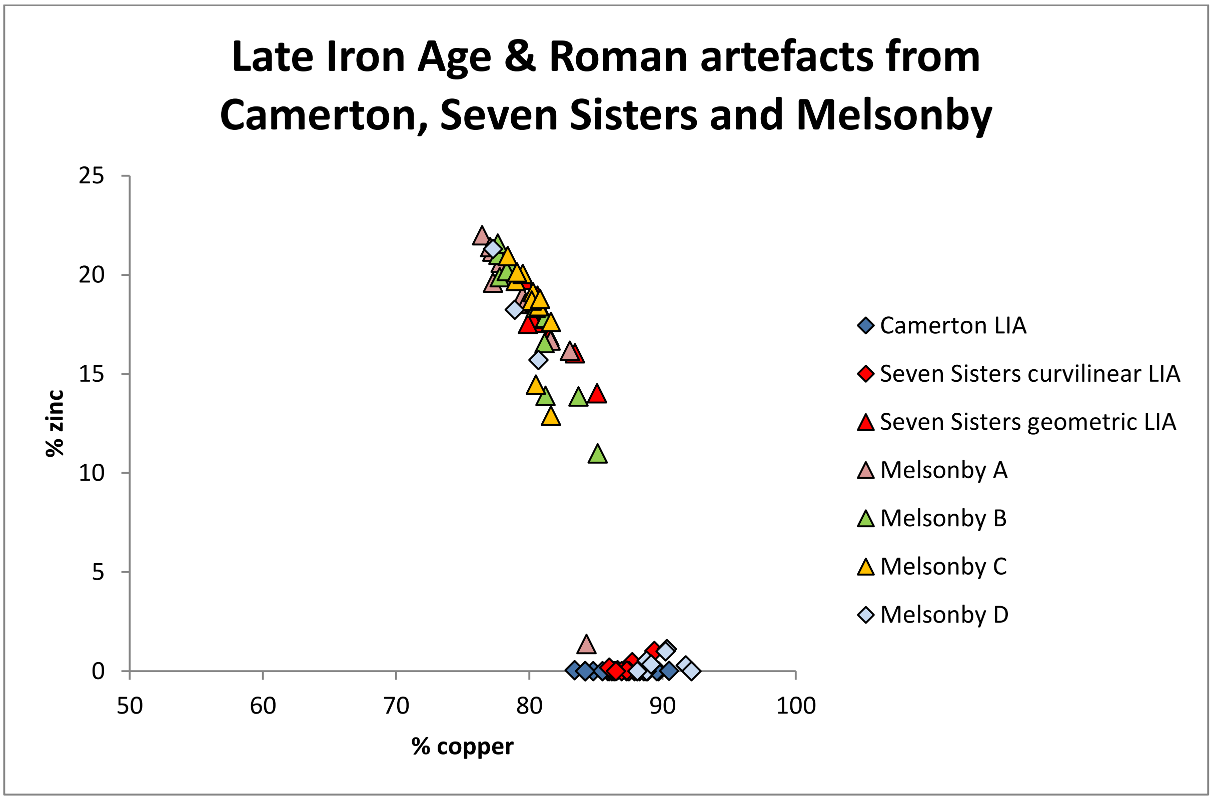


Figure 7. 44: Scatter diagram of Late Iron Age artefacts from Stanwick/Melsonby (Dungworth 1996), Seven Sisters and Camerton (Cowell 1990), showing two tight compositional groups.

Both 'curvilinear' La Tène and 'geometric' native styled objects in this hoard could be interpreted as high status artefacts, made from specific and controlled metallurgical compositions. There is no mixing of materials resulting in gunmetal, and no addition of lead, despite the fact that this was an option and the materials would have been available (e.g. Mattingly 2006 139), and could have made the technological processes of casting the metal and applying the glass or enamel easier (Bateson and Hedges 1975 185-6; Maryon 1971 174; Bayley and Butcher 2004 Appendix 1; Bateson 1981 79-81; Northover 1999 142-3).

The control and purity of the copper alloys used for the Late Iron Age objects is in contrast to some of the Roman material from the hoard. Most of the recognisable military gear is, like the native material, either bronze or brass, but of a less consistent composition. Other Roman pieces from the hoard, as with the Roman domestic material from Camerton (Cowell 1990), as well as many contemporary brooches (Bayley and Butcher 2004) and other Roman/Romano-British artefacts (Dungworth 1996; 1997, 5) are of more mixed alloys such as impure brass, gun metal and impure bronze (figure 7.45).

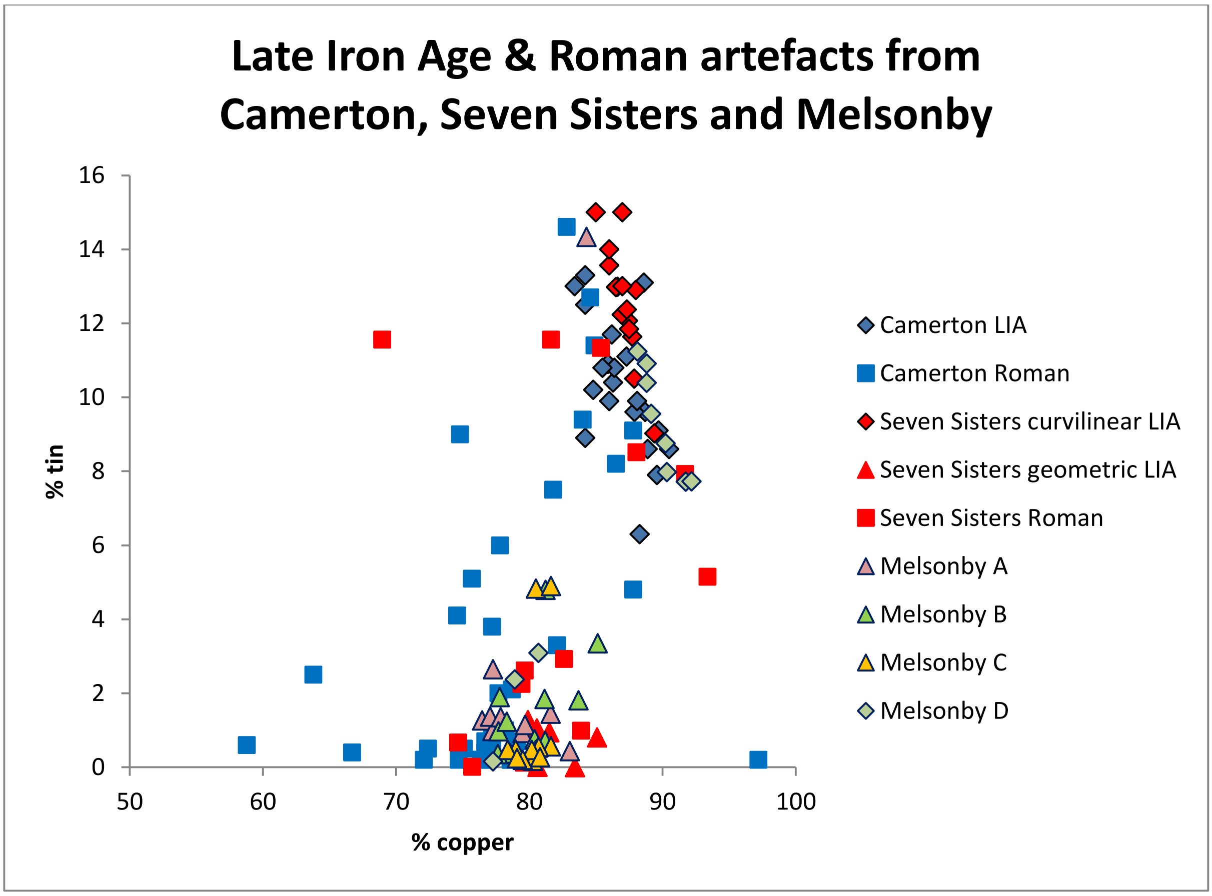


Figure 7.45: Scatter diagram of horse harness pieces from Stanwick/Melsonby (Dungworth 1996) falling largely into two groups of either bronze or brass; Roman and Late Iron Age objects from Camerton (Cowell 1990) and the Seven Sisters hoard. The Composition of Roman artefacts is much more varied.

This phenomenon of two tiers of brass quality has been commented on in relation to Roman harness fittings (Jenkins *et al.* 1985). They noticed that although zinc was regularly present in the copper alloys used for decorative or domestic Roman items, the brass was 'diluted' for these objects by the addition of scrap bronze, or occasionally copper. However, military fittings were always largely brass, and these pieces, along with brass coins were an important source for the alloy amongst the civilian population.

If this was the case, the brass harness fittings from the Seven Sisters hoard could have been made from melted down coins and military fittings; although this seems less likely for the ingots. Dungworth (1997, figure 62), puts the average zinc content in brass coins manufactured from the reigns of Claudius to Vespasian at 18-20 per cent; a reduction of approximately ten percent zinc (from re-melting) would match the levels of zinc used for the majority of the geometric style objects in the hoard; the exception again being the bridle-bit ring with different enamel composition 04.125 (which contains only c.14 percent).

Conclusion

As highlighted, the artefacts of the 'geometric' Iron Age style in the Seven Sisters hoard involved the selective use of Roman materials and technologies, but incorporated them into objects, which were of recognisably Late Iron Age style and form, and clearly contrast with the Roman military styles.

The brass used appears to be of a finely defined composition, with the craftsmen maintaining the production of a high and consistent calibre of the alloy. The zinc content closely matches what Northover (1999) suggests is the maximum quantity that can be used in a brass while still producing a good cast (average seventeen percent). The metal chosen was certainly not for ease of use in producing a cast or in attaching enamel, so implies the continuity of skilled and elite metalworkers. The composition of the enamels, and the pelta shaped brass ingots could suggest native manufacture of the materials used; or at least the acquisition of relatively newly manufactured brass, rather than the collecting and remelting of Roman scrap. Zinc ores are reasonably abundant compared to tin ores and occur in areas of relative proximity to South Wales. For example, there are extensive deposits of smithsonite (zinc carbonate) in the Mendips in Somerset (British Geological Survey 1998), an area exploited for lead soon after the Roman invasion (Mattingly 2006, 139); many zinc ore sources also exist further west and north within Wales itself (Bevins 1994). Once the cementation technique of production had been mastered, materials needed for the manufacture of brass were probably easier to obtain than those needed for bronze.

The material complexity of these objects and those from other Late Iron Age hoards contribute to understanding the relationships between the use and accessibility of Late Iron Age traditions, their communal nature and the practice of hoarding. Modifications in the use of raw materials, which show access to 'Romanising' technologies, reveal complex interactions occurring at a time of social upheaval and conflict.

Chapter 8. The Santon Hoard

Introduction to the hoard

The Santon hoard was discovered in 1897 (Von Hügel 1898, 430), by a labourer who claimed he had found it in his garden at Santon Downham in Suffolk. In 1935, Rainbird Clarke, with the aid of the rector of the parishes of Santon Downham and Santon, established that the find spot was actually within the parish of Santon (Spratling 2009, 1) and that it was on the breckland above the floodplain of the Little Ouse between Santon and Santon Downham, close to the Thetford boundary, which forms the current Norfolk-Suffolk county boundary. Additionally, and possibly significantly, although this area was probably within the Late Iron Age territory of the Iceni, it was close to the tribal border area of the Trinovantes (Davies 1996).

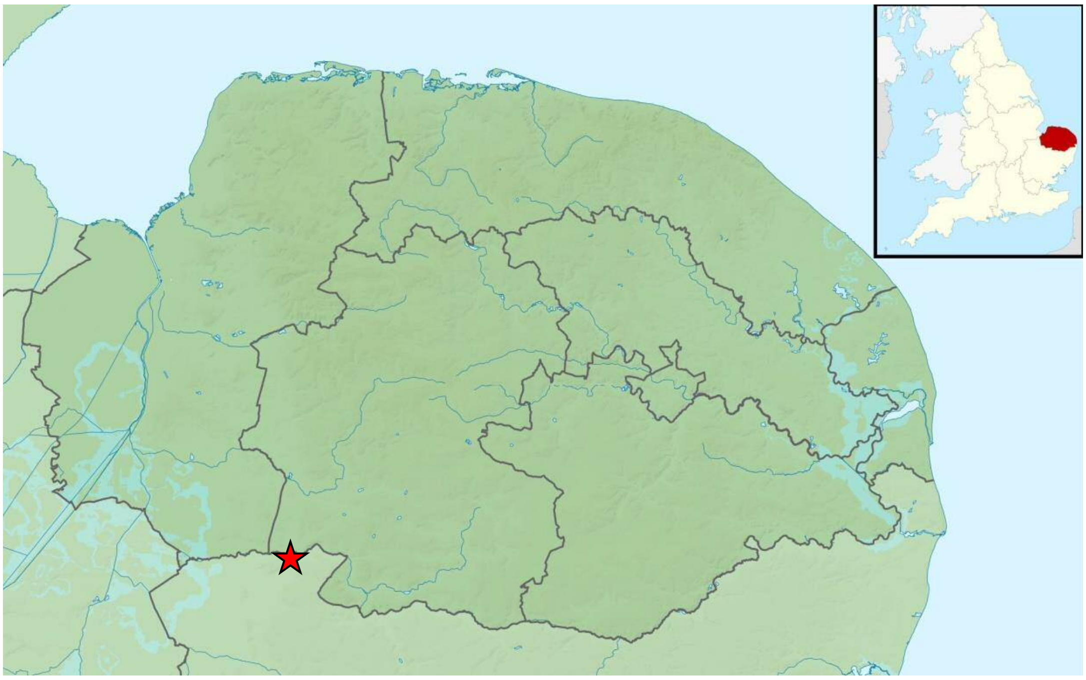


Figure 8. 1: Location of Santon hoard (http://upload.wikimedia.org/wikipedia/commons/b/b4/Norfolk_UK_relief_location_map.jpg).

The Santon hoard is in many ways much the most complex 'set' of objects studied for this thesis. It is the largest and most diverse hoard in terms of object type and material, and comes from a part of Britain where the history and politics of the region in the mid first century AD had already been much influenced by relatively diverse cultural and material stimuli from both Gaul and Rome. The tribal area attributed to the Iceni (similar to modern-day Norfolk), where the hoard is from, forms a region that is incredibly rich in terms of Iron Age artefacts dating from the Middle Iron Age onwards, including amongst other significant finds the Snettisham Treasure (Stead 1991) and the Ringstead hoard (Clarke 1951), as well as numerous coin hoards (Davies 2009). The Westhall hoard (Harrod 1855), dating to a similar period to Santon, although in present day Suffolk, was also buried in the Icenian border region.

The Iceni had become an established client kingdom (Mattingly 2006, 90) (Chapter 3), but with a history of rebellion. Artefacts present in this hoard appear to show a combination of traits; some influenced via continental connections (such as the *oenochoe* (1897.219; MS 43)), but also 'native' Late Iron Age material, such as the spectacular quadrilobed strap unions (1897.225A-B; MS: 26-7).

Such items both show some radical differences from, and confirm similar qualities to, objects present in the other hoards discussed. Although contradictory in some measure, the Santon material is important in both date and location in illustrating a national phenomenon of hoarding during the mid first century AD (Garrow and Gosden 2012, 156), but in a region which had been much more open to trade, ideas and politics from the continent. The area developed a southern and eastern tradition embracing and developing many continental and Roman practices, often seen through rich finds and characteristic burials of the Aylesford/Swarling type; this is particularly seen through the inclusion and development of vessel forms (Spratling 2009, 76-7).

Any study of the Santon Hoard has benefitted from, and is indebted to the detailed catalogue and discussion of its content undertaken by Mansel Spratling, initially in 1966 (as an undergraduate dissertation at Cardiff), and later as a revised text in March 2009 (Spratling 1966; 2009). Spratling's catalogue (2009) lists and describes 107 objects, many in great detail, and the majority of these are also illustrated. Some items are parts of much more complex multi-component objects such as vessels; and it is difficult to decipher where fragments may have come from the same or similar artefacts. Non-destructive surface X-ray fluorescence spectrometry (XRF) has helped group these fragments in some cases, where distinct compositions exist, but further detailed analysis of the objects may refine Spratling's work still further. However, it has not been possible to clarify all the issues relating to metal composition, and the hoard would still benefit from combining the current studies with a further detailed examination of all the artefacts, though that is beyond the scope of this work.

Spratling used his own numbering system in his catalogue (referred to here as 'MS'), and where possible this has been matched by the accession numbers presently used by the *Museum of Archaeology and Anthropology* (MAA), Cambridge (appendix 6). The hoard does however contain numerous sheet fragments, not easily interpreted by either system, where further sub-numbering has had to be used (appendix 6). There are also 'analyses numbers' which were used with the XRF data; these were supposed to correlate with objects, but as some of the objects have since been reconsidered in relation to other evidence, this is not always the case. In all, 133 analyses of separate 'objects' were made; some of which have multiple components and multiple readings.

Types of objects/categories

As with other hoards, many of the objects here have been subdivided into category type to gain an overall impression of the hoard, and then to enable more succinct analysis of the character of the composition of different subsets. Spratling himself had done this (2009, 72) using the divisions of

- Vessels (copper alloy, some with iron and wooden components)
- Tools and implements
- Chariot and harness equipment
- Brooches
- Small items of furniture (such as caskets)
- Roman legionary fittings
- Unidentified items ('other')

A further category has been added for this study

- 'Scrap' copper alloy pieces

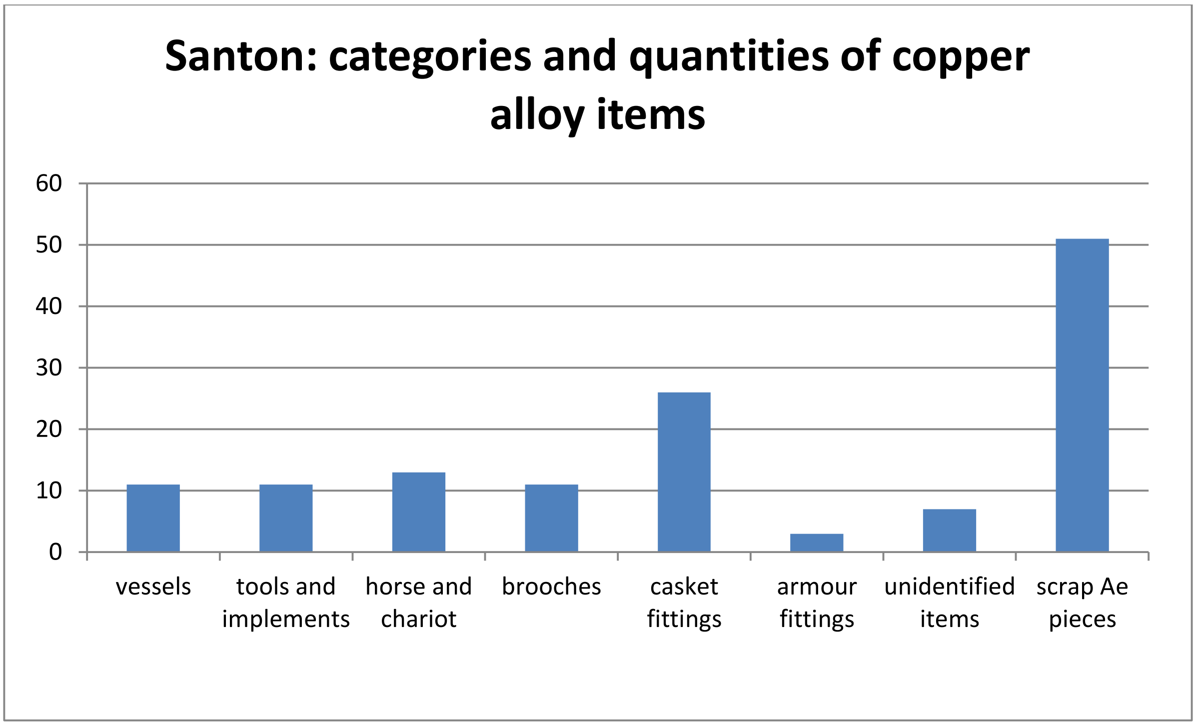


Figure 8. 2: Graph showing the number of copper alloy objects for each category in the hoard.

For this study overall groups have been assigned, mainly adhering to Spratling's interpretation (2009) (e.g. vessel staves), but partly by the physical appearance, or the elemental composition of the artefacts (figure 8.1). A few artefact types have also been reinterpreted, such as the axle caps (1897.227.20D & C: MS 72-3), described by Spratling as 'ferrules' (Spratling 2009, 56-7). There are many pieces or fragments which have been difficult to categorise; for example, Spratling's 'tools and implements' category (2009, 72) also included scrap metal (copper alloy and iron), and lumps. Many of these have been included here within the category of 'scrap' copper alloy pieces'; although a large number of these fragments may originally have been parts of vessels or other objects; they are not now readily identifiable.

Categories and the number of objects within them are complicated, and to some degree subjective; therefore tables incorporating what has been placed in each category are included in the text; this can be cross referenced with the analytical results and the object appendices (appendix 6).

Objects which are not made from copper alloy are generally not discussed, but iron and other metals, plus glass and bone artefacts are listed in appendix 6.

Note on surface analysis of objects in the hoard

Analyses of the objects in the hoard were undertaken using a hand-held XRF (X-ray fluorescence spectrometer) on the surface of each item. Sometimes multiple readings were taken; but the results form a scan of the compositions rather than a fully quantified examination, and are subject to many factors which affect the percentages given here. Qualitative analysis of major elements is not a problem for identifying the major alloy types used; however, semi-quantitative analysis (appendix 2), as used for the scatter diagrams below has to be viewed with many caveats, especially considering surface condition and geometry. XRF is a surface technique, so surface corrosion will affect the overall analysis; in brasses, zinc content is often low due to 'de-zincification', and conversely, tin can be high due to tin enrichment in the surface layers of high tin bronze (Dungworth 1997, 3.5-6;

Paynter 2007, 327). In addition to this, a proportion of the objects appear to have been chemically cleaned (stripped of surface corrosion products), while others have not (figure 8.3); specific instances where this affects results are mentioned in the text below.

Minor and trace elements are often not much above detection level, so actual quantities are difficult to determine; however, consistent results for readings from the same or similar objects buried under identical conditions from artefacts within the same hoard has meant that the absence or presence of certain elements shows some significance within categories, and the latter have been used to illustrate such differences or similarities in some of the scatter diagrams, for example in figure 8.7.

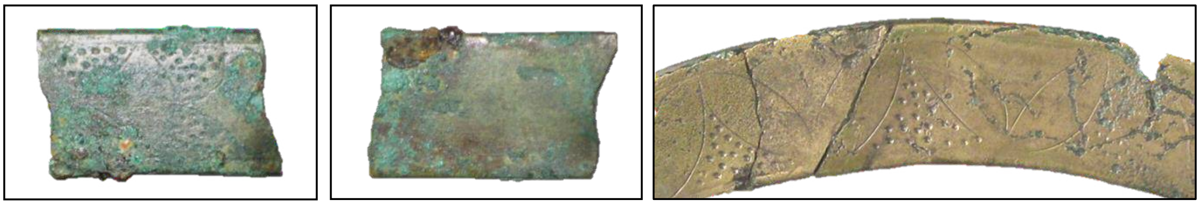


Figure 8. 3: 'Uncleaned' obverse and reverse of 1987.227.49 (part of MS 47) and cleaned section of 1987.227.50: MS 47 from the same handle.

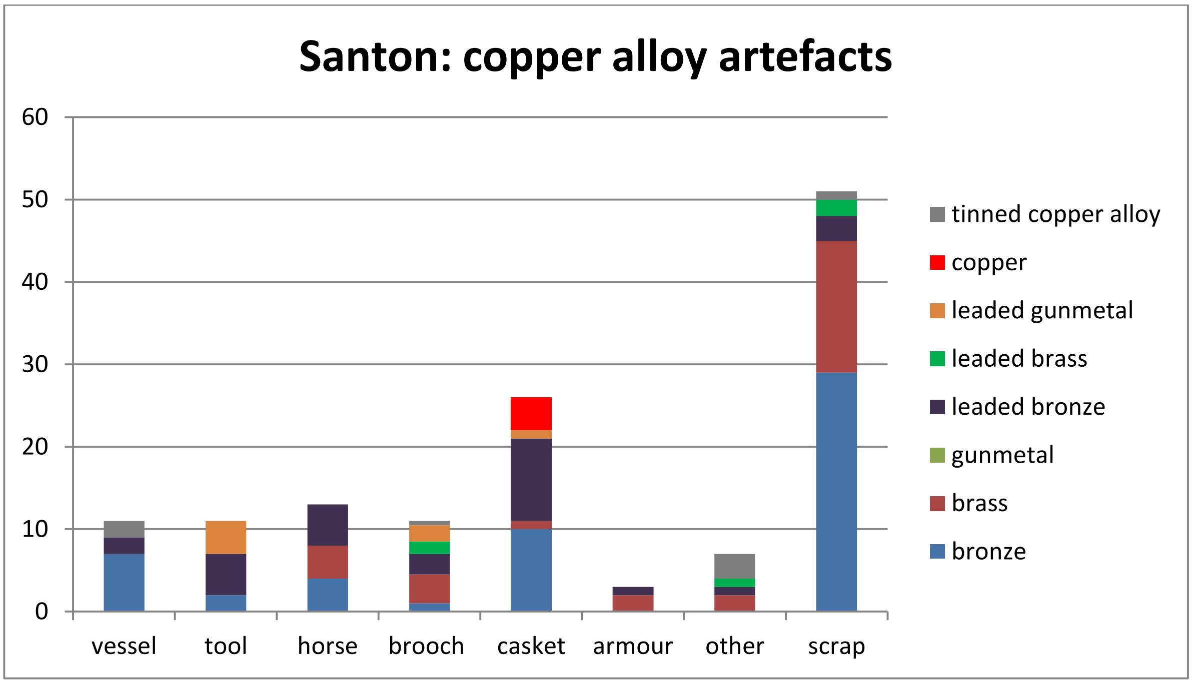


Figure 8. 4: Graph showing the use of different alloys for different object types.

The graph in figure 8.4 shows a relatively mixed picture of both object types and the variation of alloys used compared to the other Late Iron Age hoards studied here. However, there still are some discernible patterns: for example, there are no significant levels of zinc in any of the vessels. Tools form a mixed group, with a significant number of leaded bronze and leaded gunmetal objects, but the working properties of such objects, rather than their appearance would have been of uppermost importance. Brooches, many of which might be continental imports (as with the brooches from Stanway (Crummy *et al.* 2007, 314), are also very mixed in alloy type *(ibid),* and may be a reasonable reflection of the type of imported and indigenous brooches acquired and used in south east England in the mid first century AD. The use of horse related material is interesting, and shows a significant difference from the vast majority of Late Iron Age horse equipment from other hoards, in that the decorated cast items with red glass inlays from Santon show a deliberate addition of lead within the bronze.

The use of leaded gunmetal is fairly restricted, and mostly used for tools, scrap or brooches. Interestingly, non-leaded gunmetal does not feature at all; there appears to be no deliberate alloying of bronze and brass (figure 8.4); but leaded copper alloys do seem to have been re-used and mixed together.

Vessels

It should be said that the hoard itself was found within a cauldron. Additionally, there are the remains of at least ten recognisable copper alloy vessels (table 1), but originally there were almost certainly more (whether partial, broken or complete), when other iron and copper alloy fragments within the hoard are considered. Vessels are probably the most varied category from the hoard, containing classically inspired pieces, such as the *oenochoe* (figure 8.25), a Roman style *patera*/basin handle (figure 8.26), unique multi-component vessels, a spill plate from a Late Iron Age type strainer (figure 8.21) and a traditional bronze cauldron. It is also the least coherent category; many pieces are not only fragmentary, but also incomplete; the nature of metal fittings on wooden vessels accounts for some of this: as with tankard handles and folded sheet metal from the Seven Sisters hoard (chapter 7), or the possible escutcheons from the Stanwick/Melsonby hoard (MacGregor 1962, 49, 51), plus the re-interpreted iron vessel parts from that site (Fitts *et al.* 1999, 40-43). The Santon hoard appears to contain many disparate metal vessel parts; inevitably, analysis of the numbers of pieces of multi component vessel types becomes slightly subjective. For this study restored and reattached fragments are counted as one piece and single fragments are a further piece. Spratling's reconstructions of both the staved vessel (figure 8.8), and the arcaded vessel (figure 8.13), have been used to interpret many of the fragments which he believed were from these two items (Spratling 2009, 41-47; 53-55). The table below summarises the pieces classed as vessels.

Object type	MS	number	fragments	Analysis number
Cauldron/ base	42	1897.218.B.44	2	91
oenochoe	43	1897.219	2	1
patera/basin handle	44	1897.227.46	1	28
bucket base/rim	47	1897.227.51A-B	2	5; 6
vessel handle	47	1897.227.49-50	2	7; 89
staved bucket	48	1897.227.53-59	13	59; 62; 74; 77; 85; 87; 88
strainer lid (+ducks)	49	1897.223	3	15
arcaded vessel	67	1897.227.78	7	90
tinned strips	68	1897.227.57	14	78
thin curved sheets	67	1897.227.91	23	79

Table 8. 1: Table summarising the objects classified as 'vessels' within this study.

The first thing of note here is that none of these recognisable vessel fragments contain any significant amount of added zinc (although some sheet scrap metal fragments do (figure 8.62)). There are two main trends visible in the copper: tin ratios present for the vessels; the staved vessel fragments comprising 'group 2' contain a significant quantity of lead which accounts for their separation from 'group 1' (figure 8.5).

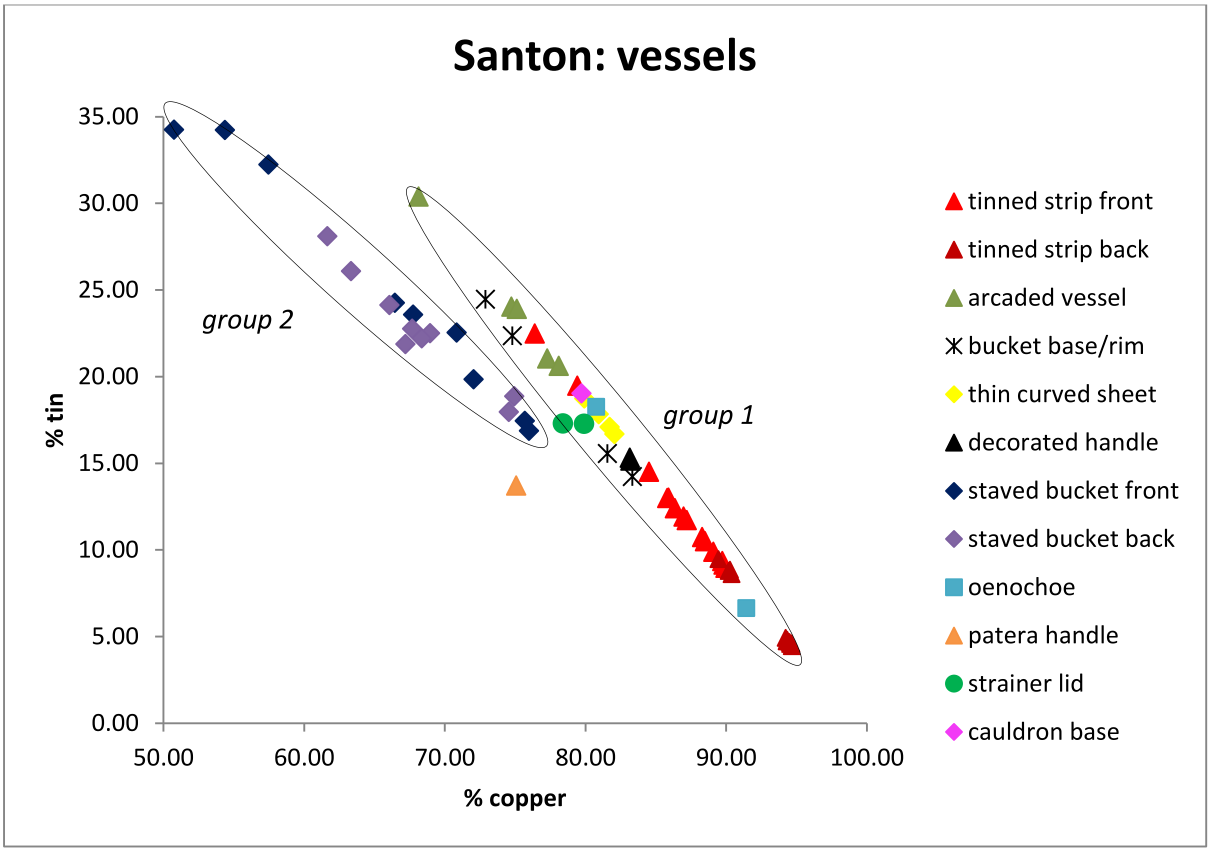


Figure 8. 5: Scatter diagram showing copper and tin contents of all artefacts classified as vessels; there are two principal groups. The *patera*/basin handle forms a distinct outlier.

A second important factor in the interpretation of these data is that all the XRF readings were taken from 'unprepared' surfaces, and this shows a further effect on the results. Although neither side of the staved vessel appears to have been tinned, or of 'white metal' in colour; the relatively high tin content on these pieces could be due to the fact that they retain much of their original surface patination (with resultant tin-enrichment occurring at the surface), whereas almost all the other vessel fragments appear to have been chemically stripped in some way. This latter factor can be seen on images of the tinned strips (1987.227.57: MS 68, figure 8.20), where corroded metal has been dissolved away from the edges; and for the decorated handle (1987.227.50: MS 47, figure 8.3), where one small fragment remains 'uncleaned' . However, the overall groups are useful and consistent and confirm the affiliation of some fragments to the same objects.

The scatter diagram in figure 8.6 shows that none of the vessels contain significant additional quantities of zinc; the tinned bucket bases/rims (figure 8.18) contain minor quantities of lead (black stars), and there are deliberately added quantities of lead to the staved bucket fragments (blue and purple diamonds) (figure 8.10) and the *patera*/basin handle (orange triangle) (figure 8.26).

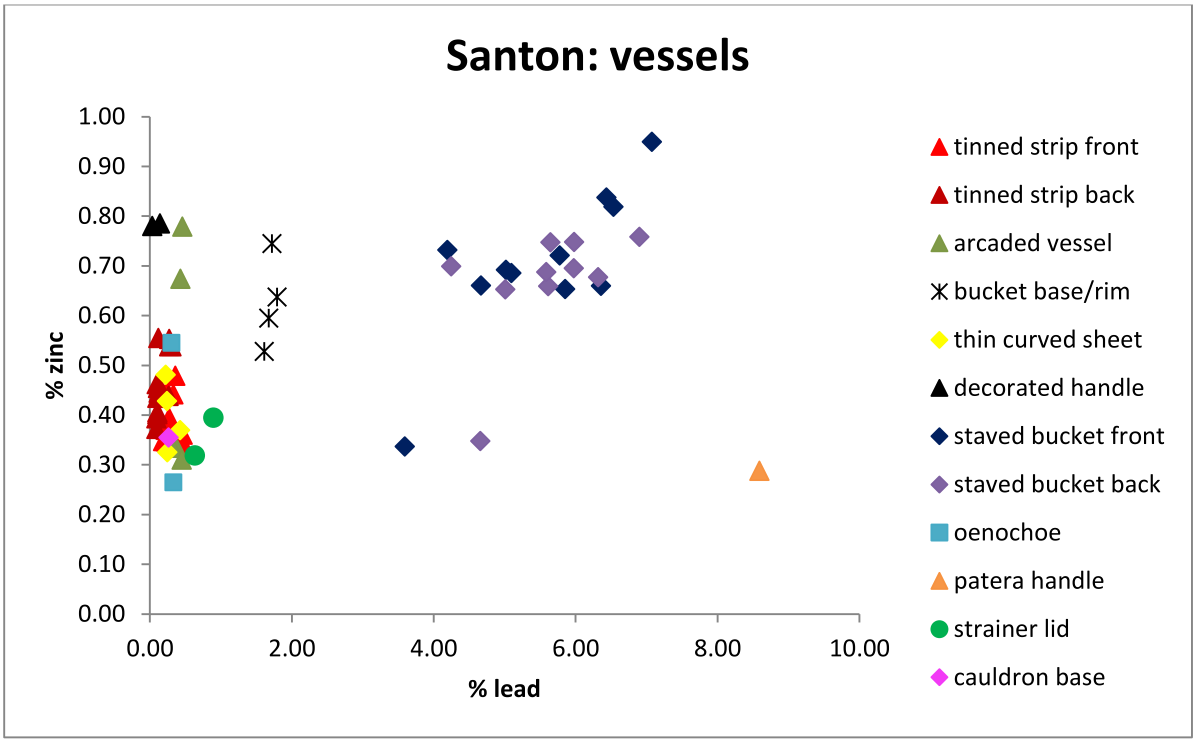


Figure 8. 6: Scatter diagram of lead and zinc content of vessels.

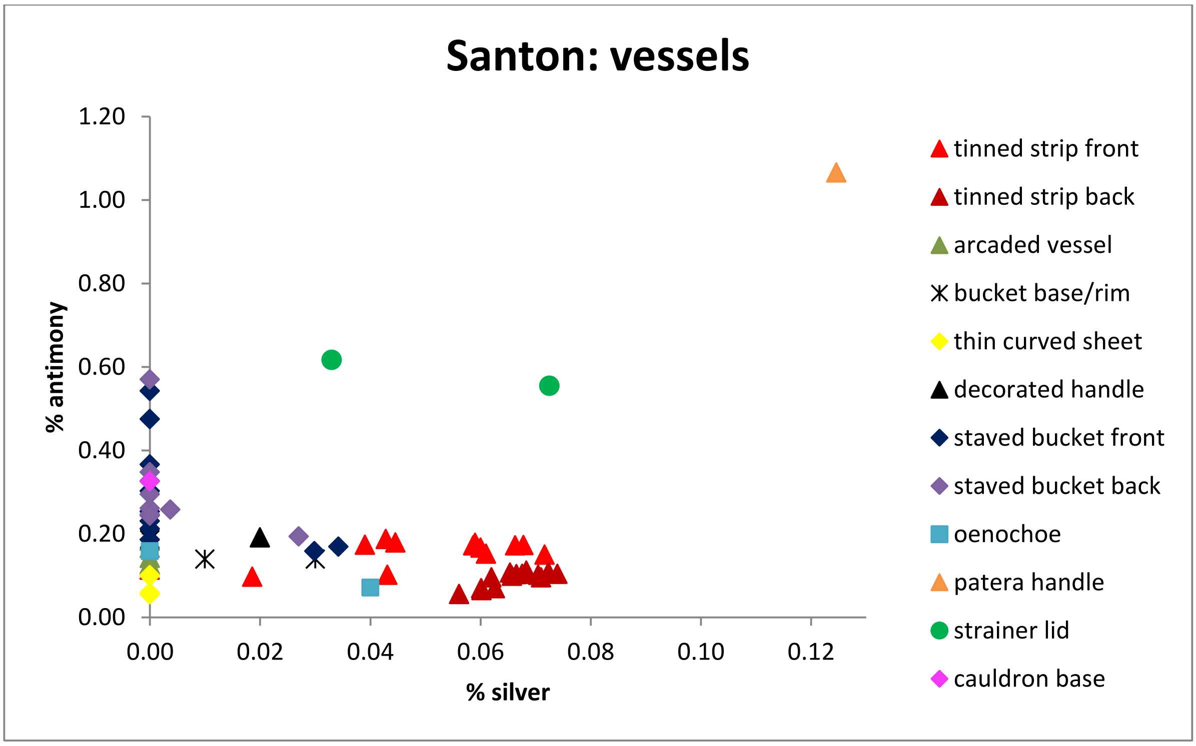


Figure 8. 7: Scatter diagram using trace quantities of silver and antimony.

The presence or absence of silver and antimony show patterns in the overall use of particular alloys for certain vessels (figure 8.7), for example the strainer lid (green circles) shows the presence of both trace metals. It can be seen that the tinned strips (red triangles) have additional silver on both the tinned and un-tinned sides, which is in contrast to the bucket base/rim where it is only present on the 'un-tinned' surfaces (black star), presumably because the tinning is obscuring readings from the bronze substrate. The two parts of the *oenochoe* (blue squares) appear to be made from different alloys.

Santon 'hooped' bucket 1 (1897.227: MS 48)

There are a large number of similarly patinated copper alloy fragments which Sprating (2009, 41-47) has reconstructed to form a small staved bucket (figure 8.8). His analysis of the fragments determined several distinct components: these included a handle; several hoop fragments, a hoop support and a rim binder (figure 8.9; 8.10; appendix 6). Elemental analysis of these fragments confirms Spratling's theory that these are probably part of the same vessel; unlike the majority of the vessel fragments from this hoard, the pieces from this bucket were clearly deliberately leaded (figure 8.6; 8.12).

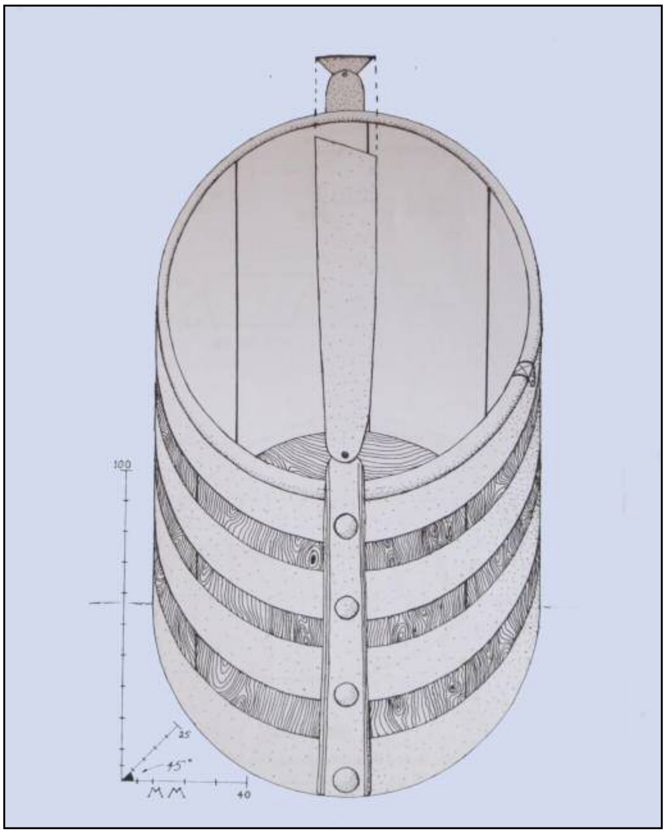


Figure 8. 8: Spratling's 'Axonometric reconstruction of bucket no. 48' (Spratling 2009, 44).

Figure 8. 9: Rim bindings 1897.227.59: MS 48H; hoop fragments 1897.227.53, 55-57: MS B4, C1, B1, C2.

Figure 8. 10: Hoop support 1897.227.58: MS 48G; handle 1897.227.54: MS 48A; all extant components are leaded bronze.

In general all the components form a discrete analytical group; but within this group, it can be seen that the different parts tend to group together to show minor compositional similarities and differences, implying that they could have been made during different casting episodes (figure 8.11). This can be seen clearly with the decreased minor amounts of zinc present within the handle and hooped supports of the vessel (figure 8.12).

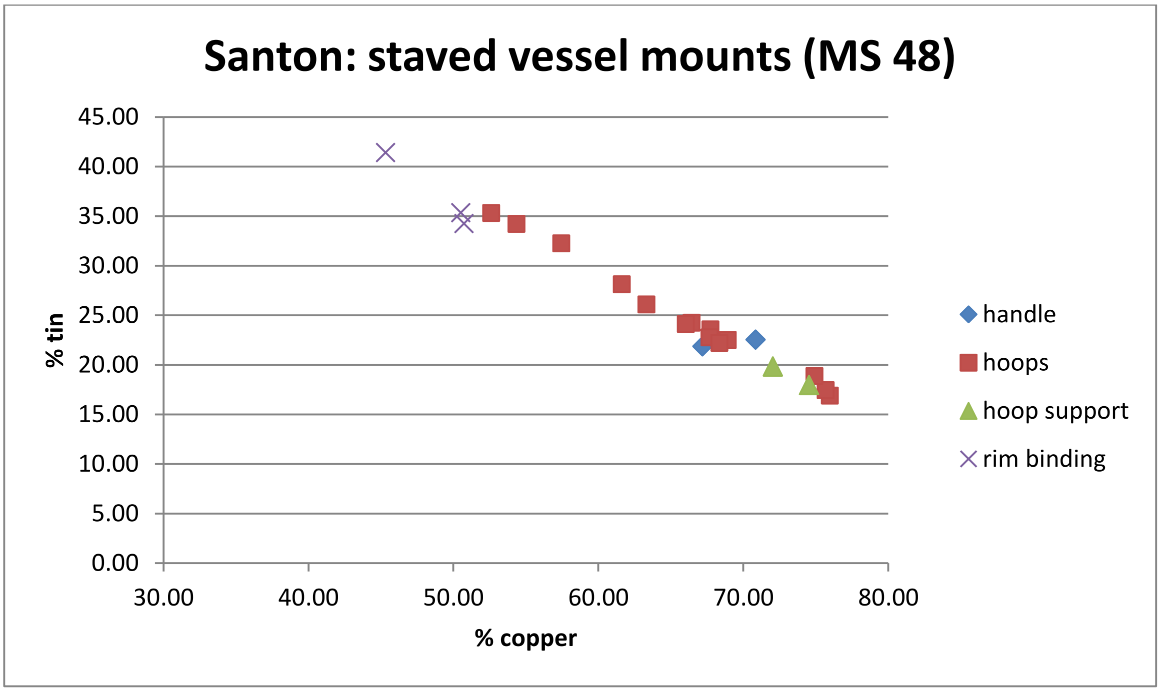


Figure 8. 11: Scatter diagram showing the copper and tin content of components from the staved vessel.

Santon 'arcaded' bucket (1897.227: MS 67)

The 'arcaded bucket' is another partial and fragmented vessel, constructed from many separate components: either perforated strips (e.g. figure 8.14) or curve-sided triangles (figure 8.13), which Spratling (2009, 53) believes from wear patterns, were originally pinned to an organic substrate such as wood. Six of the strips within the reconstruction (figure 8.15) were originally slightly longer, and bent to form angle-plates.

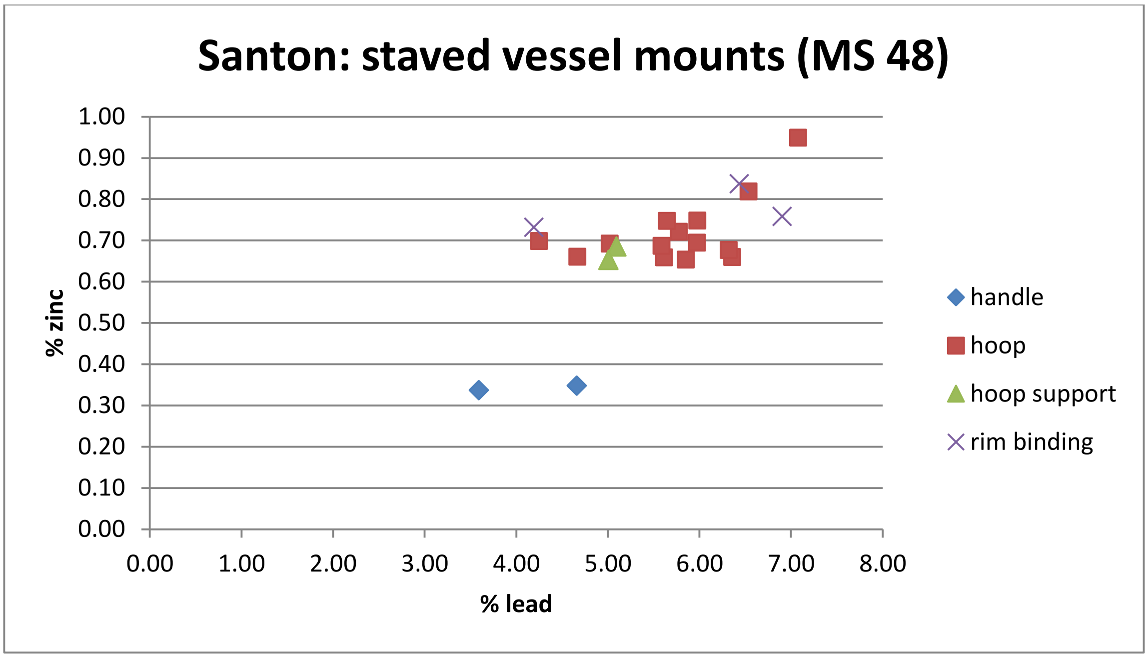


Figure 8. 12: Scatter diagram showing the lead and zinc content of components from the staved vessel.

Figure 8. 13: Modern reconstruction of arcaded vessel: 1897.227.78: MS 67, plus detail of curve-sided triangular element.

Figure 8. 14: 1897.227.78B-G: MS 68 front and reverse of perforated strips.

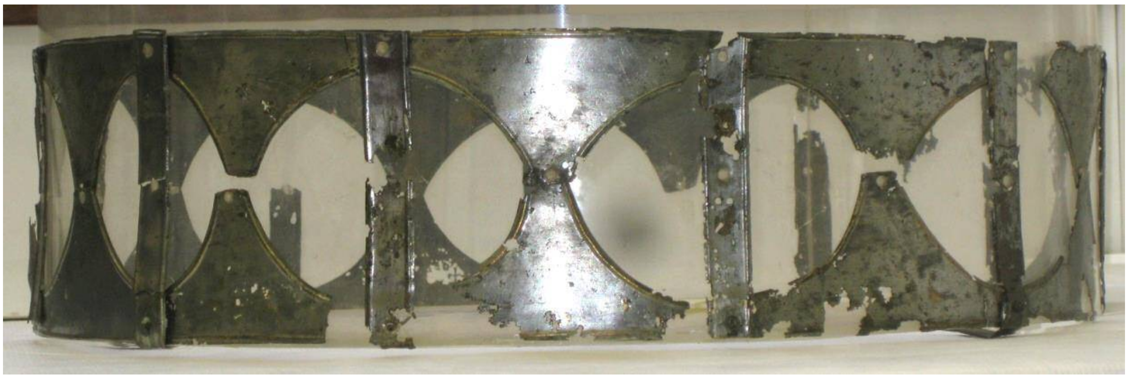


Figure 8. 15: Detail of reconstruction of arcaded vessel 1897.227.78: MS 67, showing how the separate elements are attached.

Spratling believes the above reconstruction (figure 8.15) is incorrect (Spratling 2009 55), and thinks that the original vessel had a much smaller circumference, but was taller, and 'tiered' in the manner illustrated below (figure 8.16). His analysis of the pieces and measurements suggests the original diameter would have been about 175 mm, which is very close to the size of the tinned rim and base pieces (1897.227.51A-B: MS 47, figure 8.18); and concludes that these and the handle (1897.227.5: MS 47, figure 8.19) all belong to the same vessel.

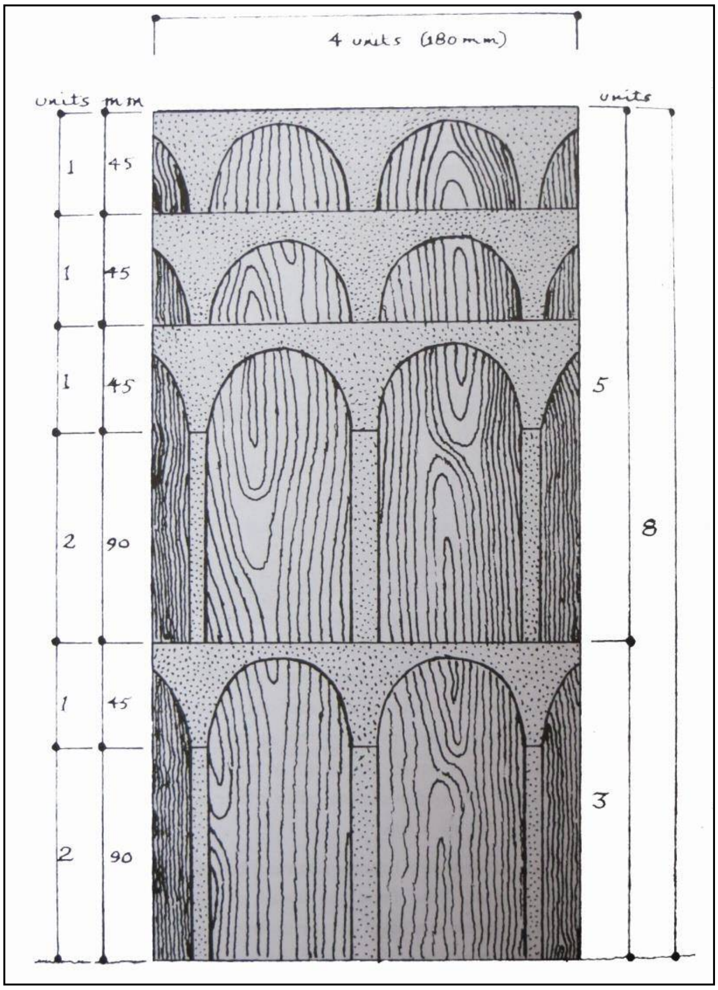


Figure 8. 16: 'Architectural bucket with tiered arcades in the Roman manner' (from Spratling 2009, 54).

As can be seen from both the photographs (figure 8.13-5; 8.17-18), and the scatter diagram (figure 8.17), there are many differences between the arcaded vessel components, the base/rim elements and the handle.

One major difference is in the surface finish; the arcaded vessel fragments are either manufactured from a white metal or are tinned on both faces; the base/rim components are tinned on one face only (figure 8.18), and the handle is not tinned. The handle also contains red glass inlay and pointillé decoration reminiscent of Late Iron Age rather than Roman or Romano-British style artefacts (figure 8.19); Late Iron Age artefacts are rarely tinned. Analysis also distinguishes these pieces; the base/rim components appear deliberately leaded, unlike the other pieces, and the handle contains higher levels of arsenic, which often signifies bronze from the Late Iron Age tradition (Dungworth 1997, 5.3.6). These observations indicate that these three different types of components are probably from three different vessels.

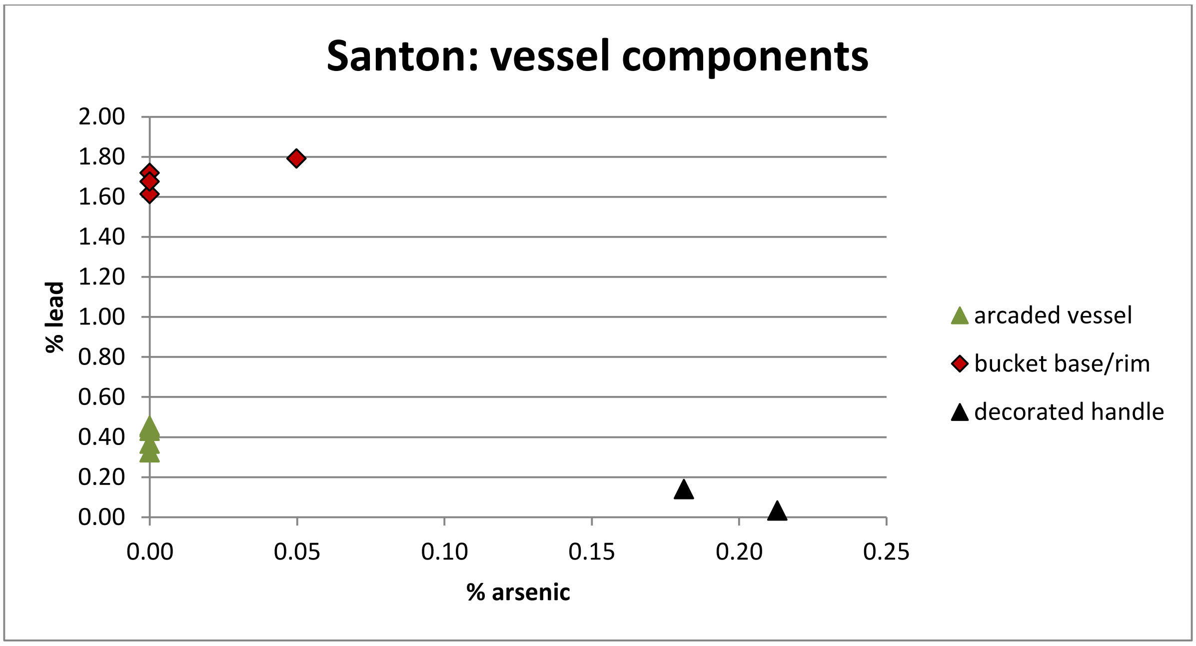


Figure 8. 17: Scatter diagram showing distinct arsenic and lead levels of component types; this calls into question Spratling's view that they belonged to the same 'arcaded' vessel.

Examination of edges, corroded components and rivet holes of the arcaded vessel does not make it clear whether the metal was coated with tin or formed from a tin rich alloy; copper and copper oxide corrosion could be seen on the surfaces in some areas and looked 'copper' coloured, but this was possibly the result of reduction and deposition of copper from within the bronze through cleaning, rather than the removal of a surface tinned layer. These components need further detailed analysis.

How these pieces were used to construct the vessel is highly conjectural, but Spratling's model is a possibility. The arcaded pieces and the perforated strips certainly appear to be from the same object. There is a parallel for an arcaded strip cited by MacGregor (1976 2, 346 and 347) from Balmaclellan, Kirkudbright: although this is possibly from a shield (Spratling pers. comm.); it has larger dimensions and no white metal is visible.

Bucket base/rim elements (1897.227.51A-B: MS 47)

Figure 8. 18: Obverse and reverse of base/rim component 1897.227.51A: MS 47. The reverse is not tinned.

Thes bucket base/rim pieces are two near-identical rings, though the one illustrated in figure 8.18 is more complete. They are made from a leaded bronze, and are tinned on one face. The elemental difference for the tinned faces can be seen clearly in figure 8.5.

Decorated 'vessel handle' (1987.227.50: MS 47)

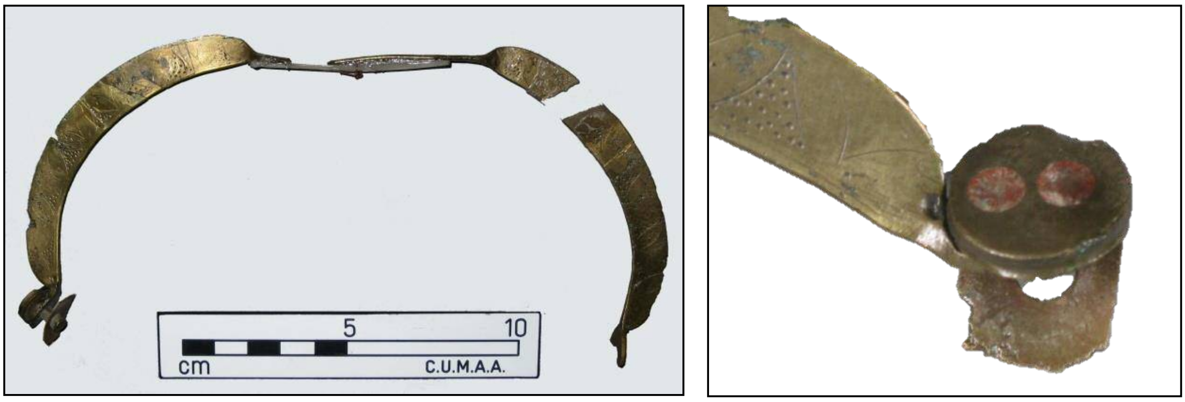


Figure 8. 19: Bronze handle with inscribed decoration and red glass/enamel inlaid terminal 1987.227.50: MS 47.

This unique object has an engraved and pointillé curvilinear design along its length on both faces, incorporating curved triangles and petal motifs (figure 8.19); the middle top section is only decorated on one face, and has a slightly different design (figure 8.3). The object is made from bronze, with a relatively high arsenic content (figure 8.17) and has two roundels filled with red glass at one of its terminals (figure 8.19).The design, metal composition (Dungworth 1997, 5.3.6) and glass all point to the indigenous Late Iron Age metalworking tradition seen on objects from hoards in western and northern Britain.

'Tinned strips' from a further vessel? (1897.227: MS67)

There are fourteen tinned strips which are squared off at both ends, and have a fine rib running down each side; some vary in length. Spratling (2009, 55) likens these strips to those used for the arcaded vessel (1897.227.78B-G; or *in situ* 1897.227.78: MS 67) (figure 8.14), but as they contain no pin-holes he presumes they are new.

Figure 8. 20: 1987.227.57: MS 68.

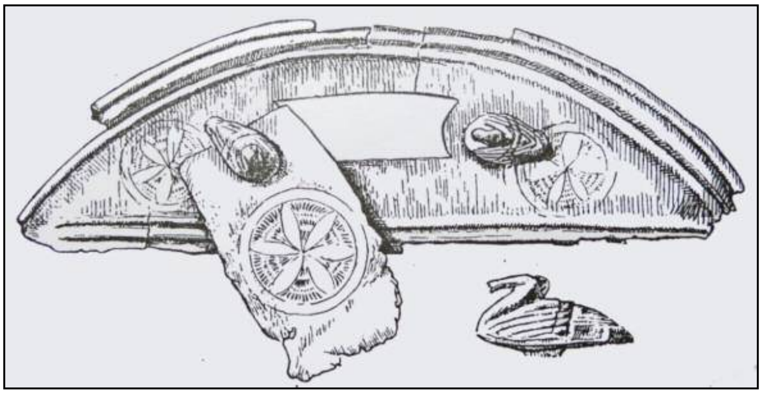
However, their composition is significantly different to those used for the arcaded vessel, (figure 8.5; 8.7), and as they have been tinned on one face only, they would almost certainly have come from, or be manufactured for, a different vessel. The fact that they are only part of an object makes their presence comparable to many of the other incomplete objects, especially composite vessel components deposited within this hoard, many of which probably originally had organic components.

Strainer lid (spill plate) (1897.223: MS 49)

The strainer lid almost certainly comes from a carinated bowl similar to those from Crownthorpe in Norfolk (Davies 2009, 10, 137-9) and from the 'Doctor's burial' at Stanway in Colchester (Crummy *et al*. 2007). These were spouted vessels containing a strainer plate; the lid was soldered to the rim of the bowl and the top of the plate (figure 8.24). There was an opening covered by a separate metal plate at the centre of the lid (figure 8.23).

Figure 8. 21: strainer lid or spill plate (1897.223: MS 49) with opening riveted on by a pair of ducks.

Figure 8. 22: detail of strainer lid or spill plate (1897.223: MS 49); showing cast duck and 'rocker' engraved design. Reverse of plate with central opening and the rivets.



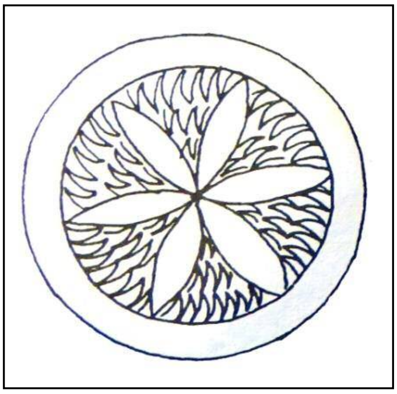


Figure 8. 23: (1897.223: MS 49) Drawing of lid with attached plate swivelled open; detail of 'rocker' engraving (from Spratling 2009, 46).

The two ducks are riveted onto the central component, and are an integral part of the original design (figure 8.23). Both the metal composition of the main part and central plate, and the style and execution of the scribed design on the two parts are very similar. A central opening in the lid broadly follows the curved upper, and straight lower shape of the lid. The strainer lid from the 'Doctor's burial' at Stanway has a missing central area (Crummy *et al*. 2007, 222, 224), and there is a missing central area or hole in a further example from Welwyn (Stead 1967). These openings therefore seem the norm; they would allow access to the part of the vessel in front of the strainer plate and behind the spout, where substances could be placed to allow infusion of herbs or medicines (figure 8.23; 8.24).

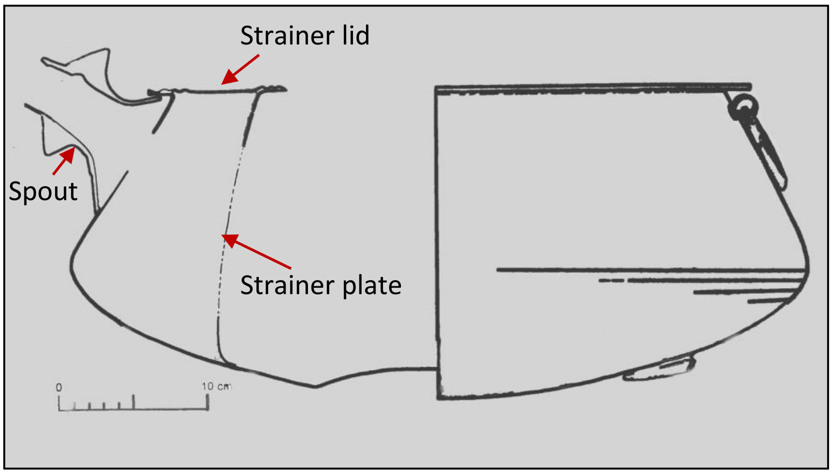


Figure 8. 24: Profile of strainer bowl from Stanway (after Crummy 2007, 222, figure 113).

Oenochoe and Patera/basin handle (1897.219: MS 43 and 1897. 227.46: MS 44)

These two types of vessels often occur as pairs, as with the 'Warrior's burial' from Stanway; the *patera*/basin was used for formal hand-washing ceremonies that preceded dining (Crummy, N. 2007, 321-2); a similar example of a *patera* exists from the Crownthorpe hoard mentioned above (Davies 2009 137-8).

Figure 8. 25: 1987.219: MS 43 *Oenochoe*, its base, and 'lion' handle.

Jugs such as the *oenochoe* from Santon (figure 8.25) are found in Britain dating from the first to second centuries AD. The ones from Santon and Stanway both have trilobate rims and handles in the form of a lion; similarly the handle and the upper part of both vessels were cast, and the lower part spun (Crummy *et al.* 2007, 186). Both vessel types have parallels across the Roman Empire, but particularly in Italy (Crummy, N. 2007, 321) and are likely to be continental imports manufactured sometime before their actual deposition.

Only the handle of the *patera*/basin survives (figure 8.26), it is made in the form of a dog's head; these handles are normally in the form of rams heads. However, some British examples do have dog heads (Spratling 2009, 39) and this could be an expression of an indigenous preference for an animal given special status within Iron Age Britain (Hill 1995; Madgwick 2008), rather than one associated with Roman sacrificial and feasting practices (N. Crummy 2007, 321).

Figure 8. 26: *Patera*/basin handle in the form of a hound (1897. 227.46: MS 44).

Thin curved metal sheets (1897.227.91: MS 79)

Spratling (2009, 59) thinks these very thin curved strips of bronze may have been used as 'casings for a wooden vessel'. There are at least twenty-three sizeable pieces or fragments (figure 8.27; 8.28; appendix 6); they have no integral strength so must have been intended as fixings onto a substrate of some kind, though there are no deliberate holes or other fixing mechanisms visible. The outer surfaces are much darker, and some of the smaller fragments in particular appear to have a blackish sooty residue (figure 8.28). The curvature of these pieces suggests they could have been used to case the pole of a chariot (Sharples pers. comm.).

Figure 8. 27: Obverse and reverse of three of the thin bronze sheets (1987.227.91: MS 79).

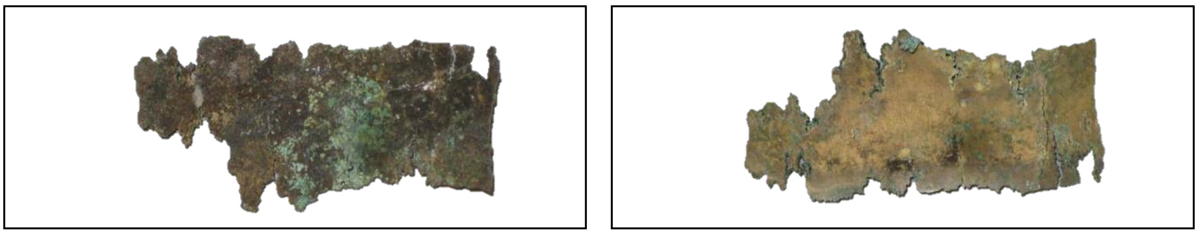


Figure 8. 28: Obverse and reverse of sheet fragment showing dark residue and corrosion products on obverse side (1987.227.91.S: MS 79).

Discussion of vessels

Vessels, as in many of the other hoards, are represented by fragments of high status feasting or drinking paraphernalia, such as ornate buckets; but the vessel types within the Santon assemblage are more numerous and varied, and as well as containing symbolically indigenous artefact types such as cauldrons, some of the objects show considerable continental influence. This represents trade or exchange with the Gallo-Roman world, and the spread of Roman decorative art and motifs (such as the lion and rams head), and thereby the resultant influence on drinking customs in south east England (N. Crummy 2007, 321). The vessels are mostly extremely fragmentary, which is to be expected, as any organic components have not survived. The many white metal pieces used for vessel fittings and decoration are very different in style to fittings and escutcheons used on buckets and tankards from the other Late Iron Age hoards in Britain.

The significance of vessels and their associations with feasting, drinking and burial rites is an enormous subject in its own right, and has been looked at in detail in other studies (Hill 1995, 2007; Ralph 2007; Horn 2012 etc.). What is significant within this study is the placing of such a large number of potentially high status vessels within hoards, for example, the tankard handles from Seven Sisters (Davies and Spratling 1976 121-147, chapter 7), escutcheons and banded vessels at Stanwick/Melsonby (Macgregor 1962 51; Fitts *et al*. 1999, 40-43), bowls and sieves at Langstone (Gwilt PAS id 244817) and possible vessel bands at Polden Hill (chapter 6) etc. It is apparent that high prestige feasting and drinking gear was as important within hoards throughout Late Iron Age Britain as it was within the high status burials in southern and eastern England; and in this respect the two types of 'burial' should not be treated completely separately, there being some overlap in the manner of conveying meaning. The burial of an individual with high-status feasting gear, such as at Aylesford or Baldock was marking the elite nature of that person within a select group, and perhaps also marking their cultural and political ties or aspirations (Hill 2007). The latter point is also relevant to hoarding: an important public occasion, which was also used to reiterate cultural and political affiliations through the use of material culture. The inclusion of such vessels (mostly large and/or communal in nature) offer further complex nuances to the process of hoarding.

A further point of interest which is worth noting is the possible psycho-active effect and inherent danger in the nature of some of the drinking rites. Within the similar strainer spout of the bowl in the 'Doctor's grave' at Stanway there was a plug of organic debris, which palynological analysis found was largely *artemisia* (mugwort or wormwood), a plant often associated with healing remedies (Wiltshire 2007, 394-5; 397-398). However, it is interesting to compare the use of *artemisia* (especially if this was used in the strainer bowl from the hoard) with that of drinking from tankards; vessel types commonly associated with indigenous Late Iron Age feasting practice. All extant tankard staves which have been identified are manufactured from yew wood; and both this and *artemisia* are toxic, psychotropic, bitter tasting and contain bio-active ingredients which in large quantities could cause death. Yew wood was known to be toxic, and there are near contemporary classical accounts of death caused by yew (Caesar, Gallic wars 6:31), and by drinking from yew vessels (Pliny the Elder chapter 20). There may have been more ceremonial bravado associated with past drinking practices than has generally been considered.

Tools and implements

Object type	MS	number	fragments	Analysis number
steelyard	1	1897.222	1	37
steelyard pan	2	1897.222	1	35
steelyard weight	3	1897.222	1	36
spade/ladle	4	1897.220	1	94
anvil	5	1897.227	1	54
stamp mould	6	1897.227	1	50
cast die	7	1897.227.7	1	29
modelling tool	70	1897.227.81	1	68
pin	71	1897.227.82	1	69
metal ring (bone tool)	96	1897.227.109	1	60

Table 8. 2: Table of objects categorised as tools and implements within the hoard.

The group of tools and implements is made up of a varied selection of objects, and largely follows Spratling's grouping within the hoard (2009, 72). It could be argued that some of these items are more significant in their use and composition than others.

Steelyard pan and weight

It could be reasoned that the steelyard pan and weight were 'significant' native Late Iron Age objects, especially as ingots and a weight are also present in the Seven Sisters hoard (Chapter 7; Davies and Spratling 1976, 138; Davis and Gwilt 2008, 179); there is also a scale pan folded into quarters from Snettisham, illustrated by Rainbird Clarke (Joy pers. comm.). Spratling states the Santon examples are based on Roman types and 'were widely used in the Roman Empire but do not admit of close dating' (Spratling 2009, 69), but it should also be noted that the steelyard has a double wavy line, seen on other Late Iron Age objects such as the Rose Ash bowl (A. Fox 1961; http://www.britishmuseum.org/explore/highlights/highlight_objects/pe/t/the_rose_ash_bowl.aspx) and the Langstone bowl (Gwilt 2014; PAS id 244817), both of high craftsmanship, and the latter certainly from a special deposit. Spratling also states that the edge of the more elaborate terminal 'is a double wavy line reserved against red enamel' (Spratling 2009, 7). If this is the case, the object can certainly be seen as belonging to the category of carefully and deliberately alloyed and decorated artefacts, reminiscent of those seen in northern and western hoards discussed in this thesis. Both the outer rim of the pan and the upper portion of the weight (figure 8.30) have a decorative incised rib; 'a favourite technique of the pre-Roman Iron Age metalworker' (Spratling 2009, 7).

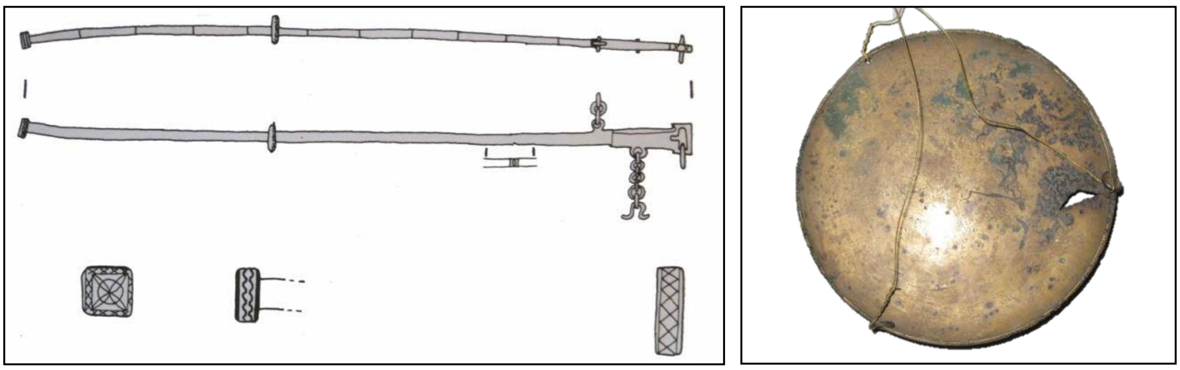


Figure 8. 29: Drawing of Steelyard 1897.222A: MS 1 (Spratling 2009, 4) and steelyard pan 1897.222B: MS 2.

The Santon weight contains similar quantities of tin to the steelyard and pan (figure 8.31), but also a substantial amount of lead, which makes sense in a practical manner (figure 8.33). Spratling believes red glass was originally present in the decorative recesses of the weight (Spratling 2009, 9); no red glass is visibly extant, though curvilinear decorative motifs are present (figure 8.30), and red glass could have been placed into voids as well as recesses, as with the decoration on the Pentyrch terret knobs (Savory 1966; 1976; chapter 7). The incised rib or cabling, as seen on the upper part of the weight, occurs regularly around decorative motifs on insular late La Tène art (Davis & Gwilt 2008, 166; Fox 1958 pl 51).

Figure 8. 30: The decorated weight (1987.222C: MS 3).

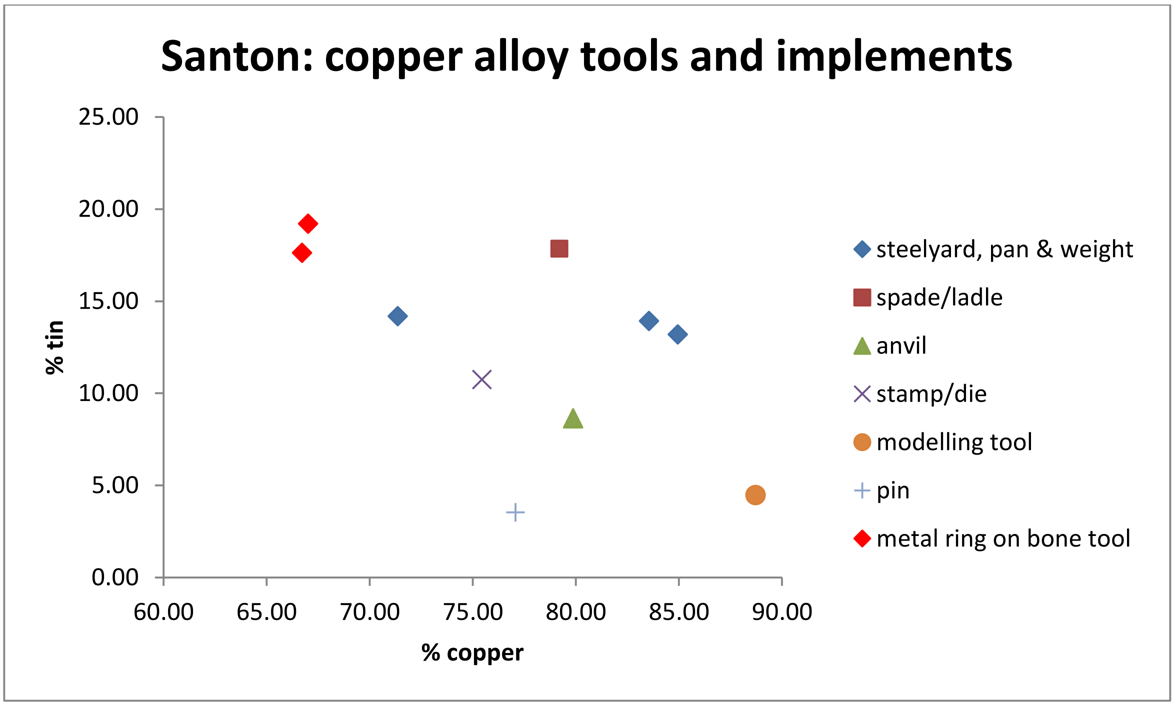


Figure 8. 31: Scatter diagram showing the varied major element compositions of the tools and implements within the hoard.

Halbfabrikat or small spade/ladle

The artefact, which Spatling (2009, 9) also refers to as a 'halbfabrikat' (a partially completed object at a stage in its manufacture), is also of unleaded bronze; but it is difficult to determine what its final form would have been (figure 8.32).

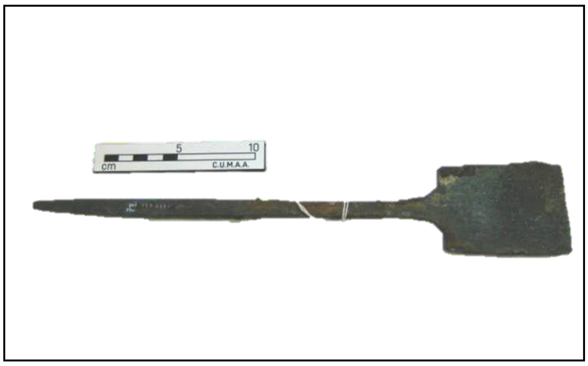


Figure 8. 32: (1897.221: MS 4); the spade/ladle or *halbfabrikat*.

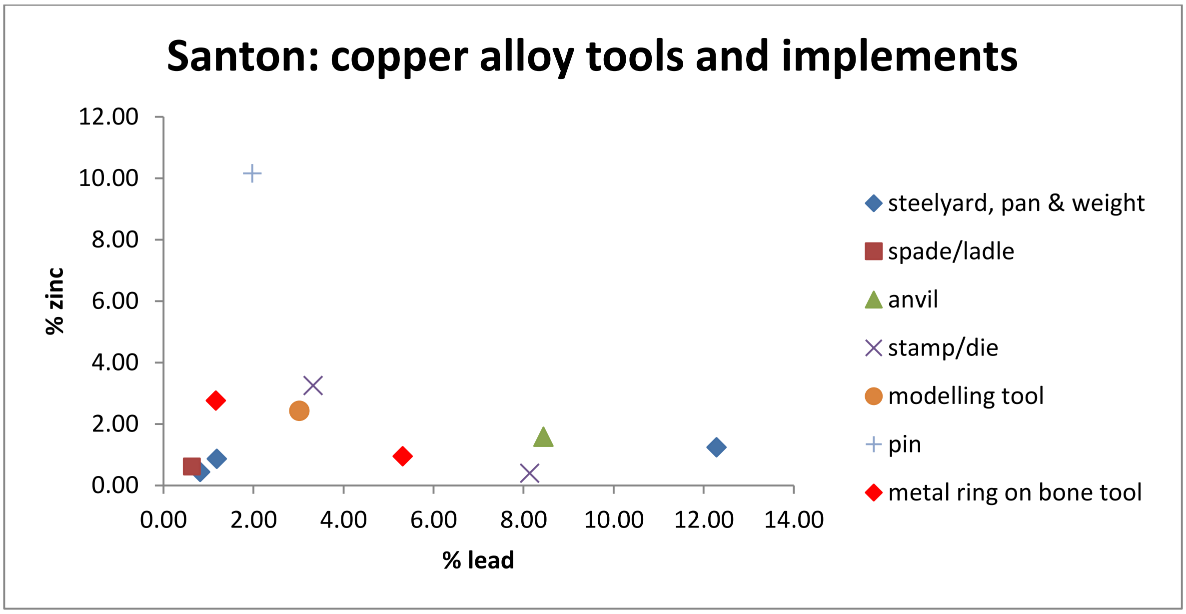


Figure 8. 33: Scatter diagram showing the lead and zinc content of tools and implements within the hoard.

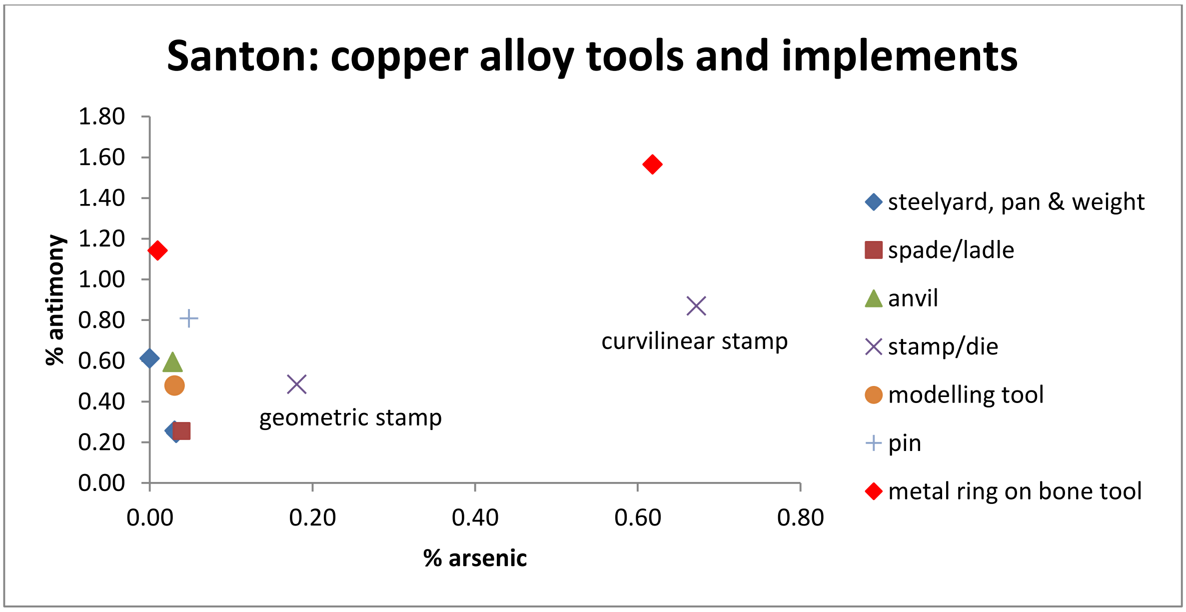


Figure 8. 34: Scatter diagram showing the arsenic and antimony content of tools and implements within the hoard.

The steelyard, pan and spade/ladle show a composition of pure bronze compared to all other tools and implements, which have a 'deliberate' addition of zinc and or lead; this again could point them out as indigenous artefacts rather than a Roman or Romano-British ones.

Cast stamp moulds

The 'geometric' boss-style stamp mould (1897.227: MS 6; figure 8.35) was probably used to decorate sheet metal, as with the casket fittings from this hoard (1897.226.76-77: MS 65-66; figure 8.50; 8.51); such metal fittings or plaques are also found in the Stanwick/Melsonby hoard (MacGregor 1962) and at Llyn Cerrig Bach (Macdonald 2007, 234-6, Plate 4, Figure 26).

The composition of the sheet metal plaques from the Llyn Cerrig Bach assemblage is interesting in relation to other metalwork from that collection, as they are lacking in both antimony and arsenic; this possibly places them as some of the latest additions to the assemblage (Macdonald 2007, 205). Although the patterns often appear insular in concept (figure 8.50; 8.51), they are mass produced, unlike the unique and freely made designs of much of insular Late La Tène metalwork. The nature of their manufacture, using repeated identical motifs, means these items were often produced in a more 'geometric' style.

Arsenic, which is often an indicator of Iron Age rather than Roman bronze technology (Dungworth 1996, 403, 410; 1997, 6.6.3) is present in larger quantities in the leaded bronze ring of one of the bone tools (1897.227.109: MS 96), but also on the cast stamp with a curvilinear design, but not on the stamp with a geometric design (figure 8.34). The difference in composition of the cast stamps might be reflected in the nature of the designs, and have some chronological or cultural significance, as curvilinear designs are strongly associated with indigenous insular metalwork. Spratling believes the 'triskele' style stamp (1897.227.7: MS 7), could have been used to produce repoussé discs for incorporation into disc brooches (Spratling 2009, 13).

The presence of lead within the stamps, as with the weight (figure 8.33), is fairly unusual for indigenous Late Iron Age metalwork, but within this area of Britain, the copying of the continental use of lead for cast bronze items, for example in the bronze from the Titelberg (Hamilton 1986) (chapter 4), would not be unexpected considering the history and connections of this area with Gaul and ultimately Rome. The practical nature of these tools, as with the weight, might also have been a factor

Figure 8. 35: Stamp moulds 1897.227: MS 6; 1897.227.7: MS 7.

Other tools and implements
All other items show a distinct lack of consistency for the alloy used (figure 8.33); most items are leaded, presumably for ease of casting and for their subsequent working properties; unlike artefacts from other hoards, many of the 'tools and implements' do not appear to been made from carefully chosen metal alloys.

Tools are an interesting category within the Late Iron Age hoards, and a small number are sometimes present in other hoards (as with the Polden Hill hoard chapter 6). The Santon hoard has an eclectic mix, including means of weighing, stamping and working metal. This category of objects has often helped to strengthen the arguments that these Late Iron Age assemblages were founders' hoards (Davies and Spratling 1976, 139; Spratling 2009, 75), or as in the case of Santon, a metal smith's burial (Spratling 2009, 78). However, as with other mixed assemblages and deposits, they could equally well represent groups of people contributing to the hoarding process rather than the miscellaneous and diverse collections of an individual.

Horse and Chariot equipment

Object type	MS	number	fragments	Analysis number
quadrilobed strap union	26	1897.225A	1	2
quadrilobed strap union	27	1897.225B	1	3
two link bridle-bit	28	1897.227	2	30 (x2)
decorated hoop folded	31	1897.220.41	1	49
decorated hoop fragment	32	1897.220.40	1	43
nave band	33	1897.220.	1	92
nave band	34	1897.220.	1	93
nave band main part	35	1897.220	1	31
nave band tightener	37	1897.220	1	31
nave band main part	36	1897.220	1	32
nave band tightener	38	1897.220	1	32
axle cap	72	1897.220D	1	34
axle cap	73	1897.220C	1	33

Table 8. 3: Table detailing horse and chariot (or cart) equipment.

The horse and chariot equipment within this hoard are important for comparison with the contents of the other Late Iron Age hoards discussed in this thesis. However, the overall ratio of this type of item within the Santon hoard is relatively small, and equipment for the horse itself, rather than for a cart or chariot is smaller still. This group of artefacts also illustrates how some objects within the hoard appear new or unused such as the strap unions, while others such as the nave bands and bridle-bits are squashed or broken and worn. This phenomenon is clearly seen in other hoards such as Polden Hill (chapter 6), Seven Sisters (chapter 7) and Middlebie (chapter 9).

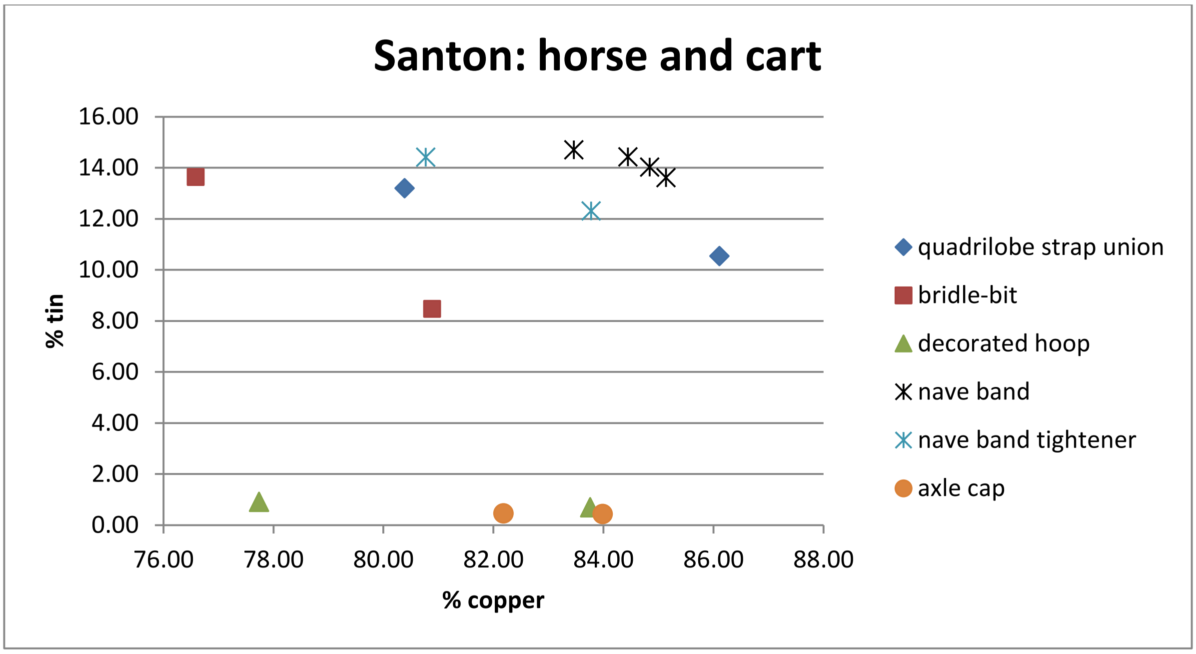


Figure 8. 36: Scatter diagram showing the copper and tin content of the horse equipment.

Nave bands and axle caps

The most numerous of the cart or chariot related objects are the nave bands (1897.220 and 1897.227.20 A&B: MS 33-38) (figure 8.37). There are four of these plus two associated tighteners; the bands themselves appear to be from the same original metal batch, and were possibly made as a set. However, slight differences in the major and trace alloying elements (figure 8.36; 8.38; 8.41) imply different casting episodes for making the 'tighteners'. For example, the tighteners contain slightly more lead and zinc than the bands (figure 8.37); this suggests that although the same original source of metal was used, it is possible the tighteners contained additional scrap metal incorporated within the molten bronze when these further items were cast.

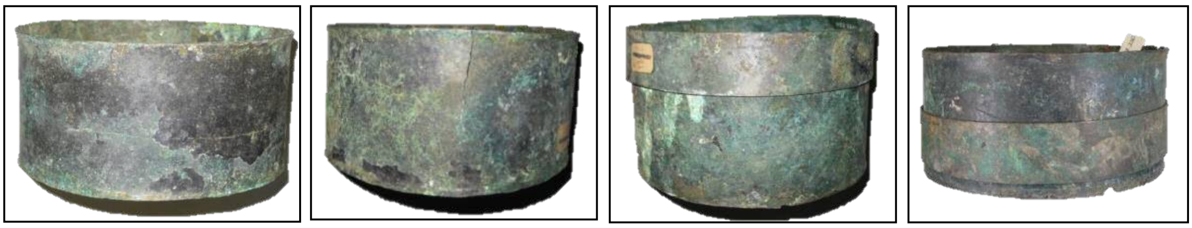


Figure 8. 37: Nave bands and nave bands with tighteners *in situ:* (1897.220: MS 33 & 34 and 1897.227.20 A & B: MS 35-38); MS 33 has a mark where it once had a tightener.

The two further categories of cart or chariot related objects are the two axle caps - if this is the correct interpretation of the function of these objects (see appendix 9) (1897.220 C-D: MS 73 & 72), (figure 8.42) and the decorated nave hoops (1897.220.41: MS 31 and 1897.228.40: MS 32; figure 8.39). All these are here made of brass, which would have given them a decorative gold-like appearance. The two decorated hoops, though both brass (figure 8.38), are from separate metal sources, given the variation in both their copper content and minor/trace element composition (figure 8.41).

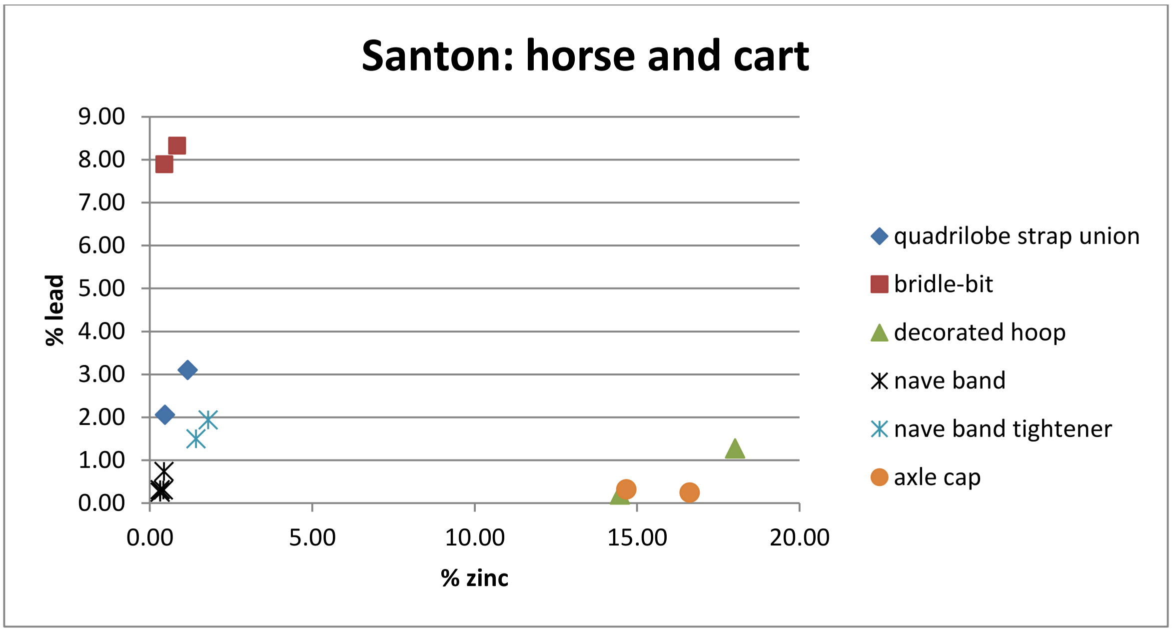


Figure 8. 38: Scatter diagram showing the zinc and lead content of the horse equipment; the 'tighteners' contain slightly more zinc and lead than the nave bands.

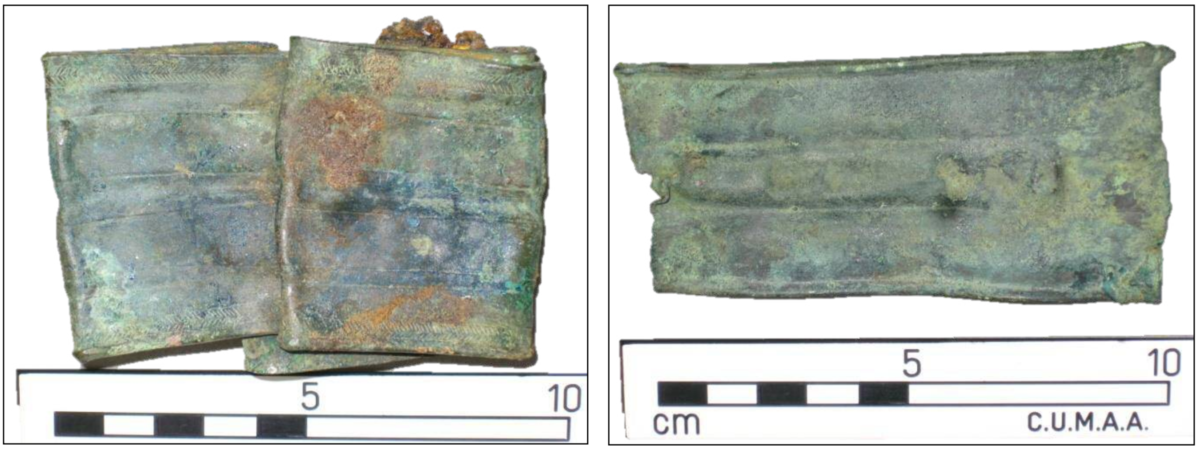


Figure 8. 39: decorated brass nave hoops (1897.220.41: MS 31 and 1897.228.40: MS 32).

Quadrilobed strap unions

For the horse equipment itself it can be seen (figure 8.41) that there are relatively high levels of arsenic present in the quadrilobed strap unions; in this respect the production of these artefacts fits in with indigenous Insular Late La Tène curvilinear metal working traditions rather than Roman ones However, the inclusion of lead is once again different from Late La Tène horse equipment with red inlay from the other hoards. Lead would aid the casting process and its addition makes sense from a technological point of view, but the use of lead appears to be strictly avoided on similar pieces, for example those in the Polden Hill hoard (chapter 6). The small quantities of zinc present do not look deliberate. The red glass was not sampled for analysis, and it would be interesting to look in detail at its composition to see whether a classic sealing wax red glass was used, or a Roman type composition (chapter 5), both of which were present on the horse brooch from Polden Hill (chapter 6), and Roman style glass was used for the Langstone bowl escutcheon (Gwilt 2014; appendix 8).

Figure 8. 40: The two decorated quadrilobed strap unions from the hoard (1897.225A & B: MS 26 & 27).

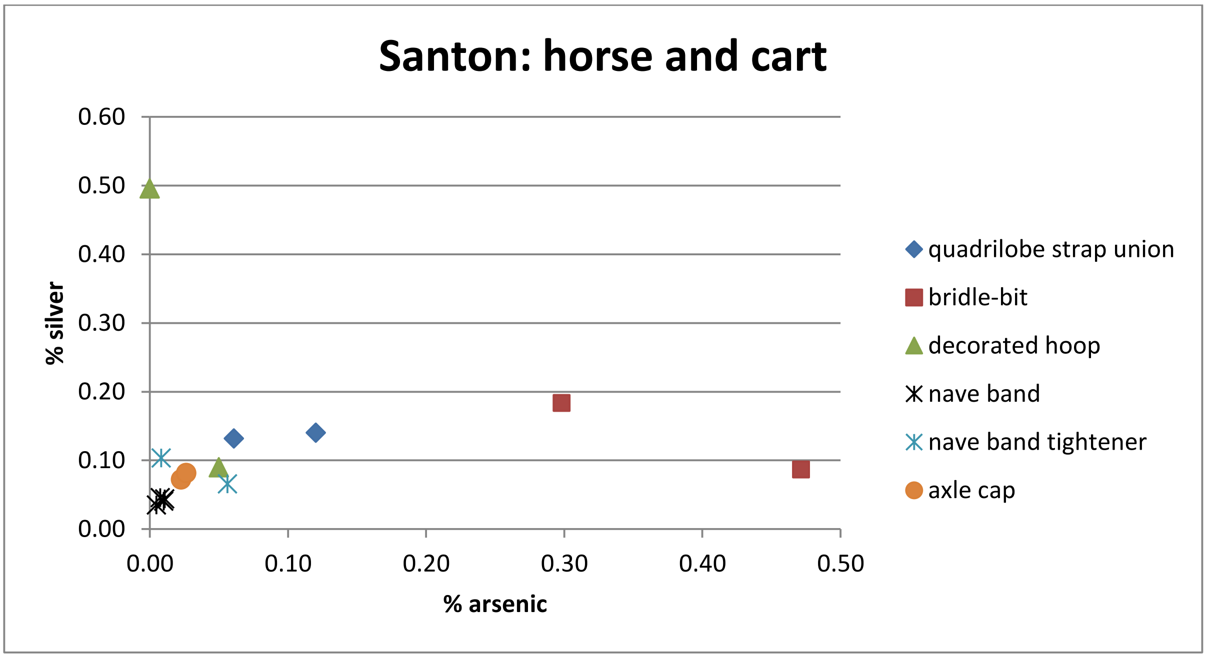


Figure 8. 41: Scatter diagram showing the trace arsenic and silver content of the horse equipment.

Figure 8. 42: Bridle-bit (1897.229: MS 28) and brass axle cap (1827.20C: MS 73).

Bridle-bit

The two link bridle-bit is of a similar type to those in the Polden Hill hoard; and as with some of those pieces, inlaid red glass looks to have fallen from the drilled recesses on the wings of the link (chapter 6). As stated above, leaded bronze is unusual for Iron Age horse gear (figure 8.38). The major element composition of each component of the bridle-bit is varied, but this is understandable as two different casting episodes would be needed to cast the link onto the ring. Minor elements suggest both components were from a similar metal source, and the high arsenic content (figure 8.41), is typical of metalwork made in the Iron Age tradition (Dungworth 1997).

John Davies has described the Iceni territory as 'The Kingdom of the Horse' (Davies 2009, 109); but, there are proportionately fewer pieces of horse furniture in this hoard than in the western and northern examples, where such items are often the most predominant artefact type (Polden Hill, Stanwick/Melsonby, Seven Sisters and Middlebie). However, the strap unions are among the finest pieces of extant Late Insular La Tène art. Chariot or cart fittings such as nave hoops and axle caps are represented in this hoard, but terrets, one of the most common and numerous Iron Age horse related artefact type, are not represented at all.

Brooches

There are eleven brooches, including the embossed disc, and the types represented are those often found within first century AD contexts (Bayley and Butcher 2004; Dungworth 1997, 7.2)

Object type	MS	number	fragments	Analysis number
dolphin brooch	15	1897.224 A	1	40 (x3)
dolphin brooch	16	1897.224 B	1	46 (x2)
dolphin brooch	17	1897.224 C	1	45 (x2)
dolphin brooch	18	1897.224 D	1	47 (x2)
Hod Hill type brooch	19	1897.224 E	1	38
flat-bowed brooch	20	1897.224 K	1	39 (x2)
thistle brooch	21	1897.224 G	1	41 (x2)
thistle brooch	22	1897.224 H	1	52 (x4)
thistle brooch	23	1897.224 I	1	42 (x3)
thistle brooch	24	1897.224 J	1	48 (x3)
Embossed plate brooch	25	1897.224 F	3	8 (x4)

Table 8. 4: Table listing the brooches from the hoard.

Brooches became increasingly commonly used within the Romano-British period (Bayley and Butcher 2004, 206), and with this augmented popularity and access, there was also an increase in the number of alloy types used for their manufacture. Initially new types of brooch such as the Colchester types (different to the British pre-Roman brooch traditions), were of continental origin and almost certainly imported from Western Europe (Bayley and Butcher 2004, 147), and 'it is clear that brass was the normal brooch-making alloy in use on the continent at this period' (*ibid* 209-10). The Hod Hill type (1897.224.E: MS 19) (figure 8.43) was also common in Western Europe, but rarely are exact duplicates or parallels found in Britain (Dungworth 1997, 7.2). Brooches such as these seemed to replace traditional British Iron Age bronze and iron ones (Bayley and Butcher 2004, 207); the Santon 'Hod Hill' example is typical, having no exact parallels and being made from brass (figure 8.43; 8.44).

Figure 8. 43: Examples of brooch types in the Santon hoard (1897.224.A/E/K/G: MS 15, 19, 20, 21): dolphin, Hod Hill, flat-bowed and thistle (or rosette).

Tinning, a technology largely introduced at the time of the Roman conquest in the first century AD, became commonly used in Britain for its decorative effect on brooches, as with the flat-bowed brooch (1897.224.K: MS 20) (figure 8.43), and the embossed disc 1897.224.F: MS 25) (figure 8.47).

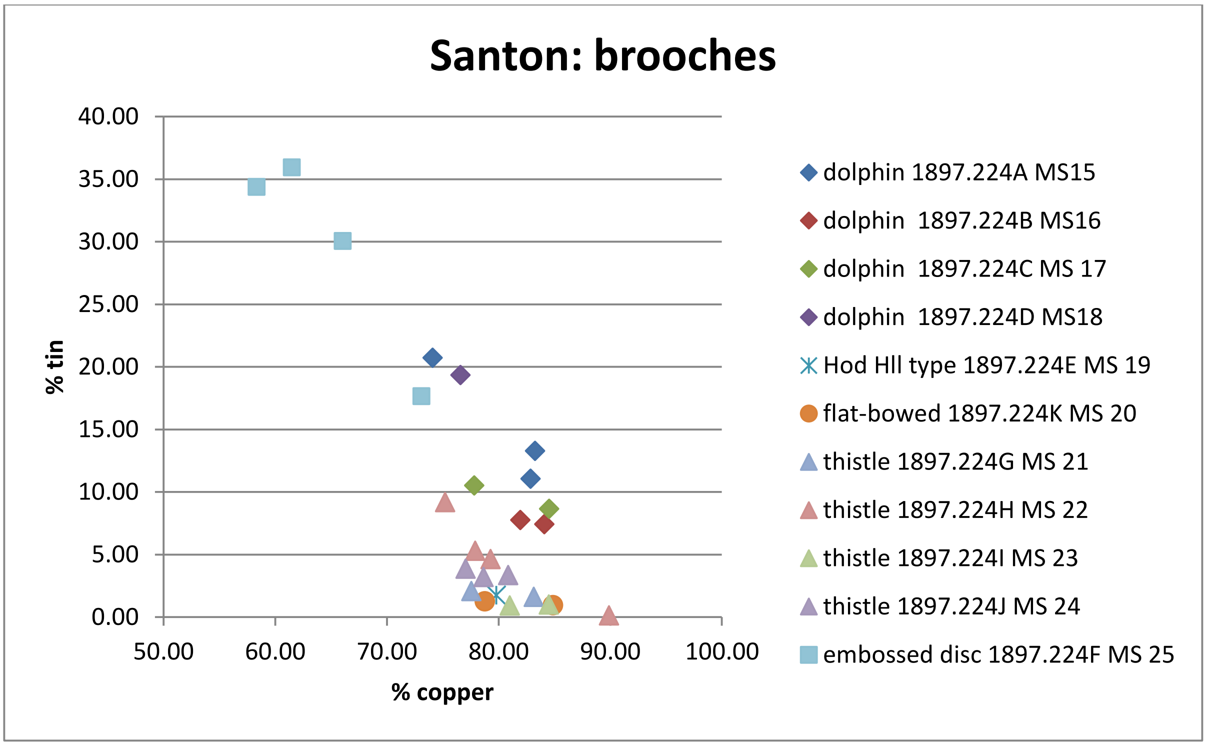


Figure 8. 44: Scatter diagram showing the copper and tin content of brooch and brooch components within the hoard.

A stated above, first century AD brooches made within Britain were often derived from imported continental types; during the period in which most of these hoards were deposited, major technological changes were occurring in both the alloys used, and their method of production. Many brooches started to be cast in two-piece moulds rather than made from hammered and wrought bronze. This was not only a quicker method of manufacture, but it also allowed for mass-production to some extent. The addition of lead to cast items, not commonly seen in Late Iron Age technology, was an advantage for their ease of manufacture via casting (Bayley and Butcher 2004, 207).

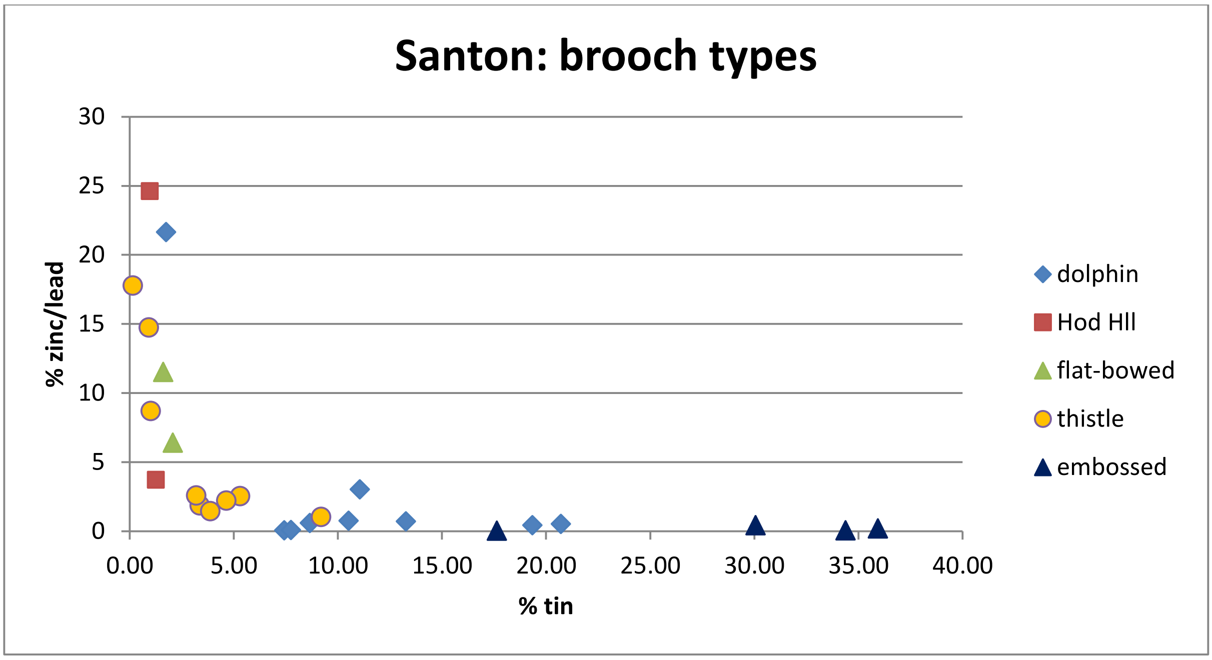


Figure 8. 45: Scatter diagram of tin versus zinc/lead content of components of different brooch types.

The scatter diagram (figure 8.45) illustrates the patterns in different types of composition for different types of brooch from Santon, which confirms Bayley and Butcher's general conclusion that 'main brooch types are found to consist of one alloy type' (Bayley and Butcher 2004, 206).

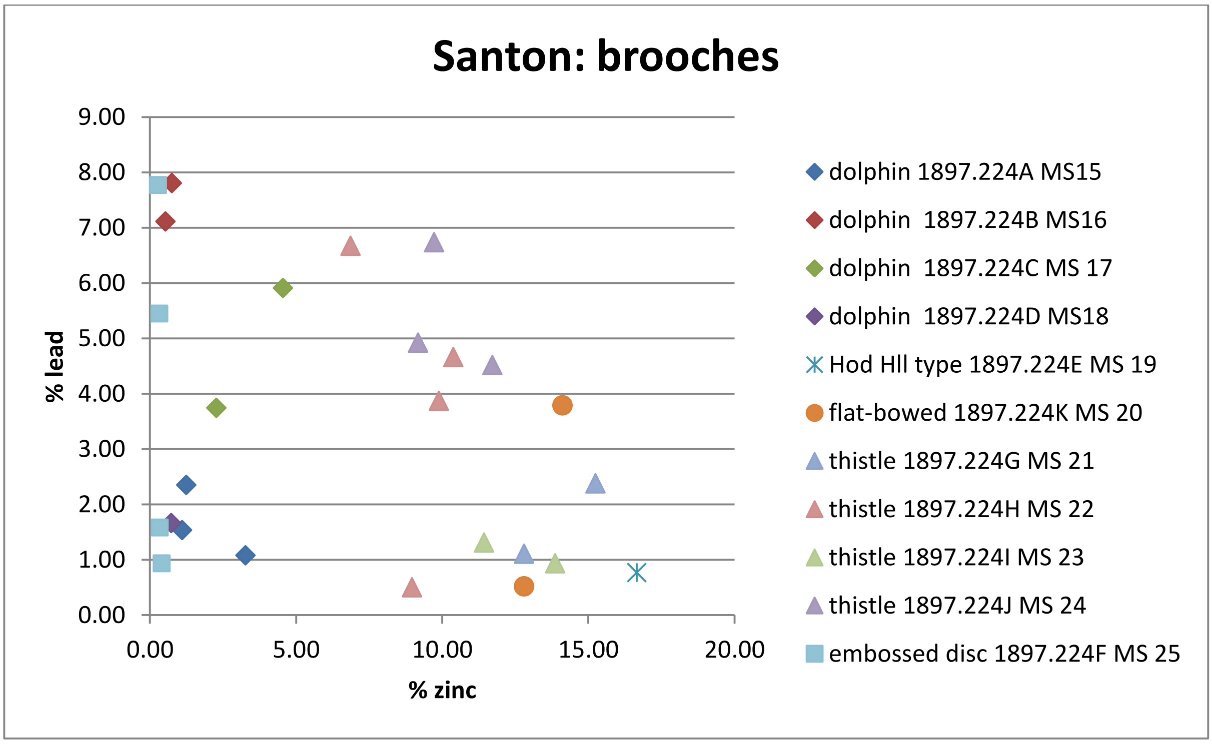


Figure 8. 46: Scatter diagram of zinc and lead content of the components of different brooches and brooch types within the hoard.

The composition of the dolphin brooches is similar to other analysed examples, predominantly leaded bronze (diamond shapes in figure 8.46), which ' is a very characteristic British alloy in the later first and earlier second century, being used for ... Dolphin...brooches'(Bayley and Butcher 2004, 210; Dungworth 1997, 7.2).

Thistle brooches from the Santon hoard are slightly different in that although predominantly a copper zinc alloy (figure 8.43; 8.44; 8.46), they have quite a mixed composition, with many of their components incorporating significant levels of lead and occasionally tin (figure 8.44; 8.46); this finding differs slightly from those in the Richborough assemblage, which are mostly unleaded (Bayley and Butcher 2004, 150). According to Bayley and Butcher Rosette/thistle brooches 'have a wide distribution in Gaul and on the German frontier but are also represented in southern Britain' *(ibid).*

Figure 8. 47: The three components of the embossed disc (1897.224F: MS 25).

The bronze embossed disc appears to have three components; one with a stamped or repoussé winged horse design, a tinned perforated disc, and a further disc which possibly once held a catch-plate (figure 8.47). It closely resembles a type of plate brooch which Bayley and Butcher think is best paralleled in the German provinces; although these are normally dated to the second century AD, so later than the Santon example (Bayley and Butcher 2004, 130-131, and plate 23).

In general, analyses of the brooches from the Santon hoard support the argument that 'for most (brooch) types there was a preferred alloy which was used to make a high proportion of the analysed examples' (Bayley and Butcher 2004 208).

There are a relatively large number of brooches within this hoard, all of which show signs of wear or have been broken, and as Spratling points out 'an assemblage with as many as eleven brooches is a rarity in Britain in the early to mid-first century AD' (Spratling 2009, 73), although the Polden Hill hoard does contain six examples.

Casket fittings (small furniture items)

There are several objects within this hoard which have been ascribed as 'casket fittings'. These consist of one relatively large and elaborate drop handle and four smaller examples, which appear to make up two pairs (figure 8.48); ten detached metal legs, which seem to form two sets (figure 8.49); and various lengths of similarly embossed strips, plus three small embossed plaques of a different design (figure 8.50; 8.51).

Object type	MS	number	fragments	Analysis number
handle	50	1897.227.63	1	10
handle	51	1897.227.61	1	11
handle	52	1897.227.62	1	12
handle	53	1897.227.64	1	13
handle	54	1897.227.65	1	14
casket leg	55	1897.227.67	1	19
casket leg	56	1897.227.71	1	23
casket leg	57	1897.227.68	1	20
casket leg	58	1897.227.70	1	22
casket leg	59	1897.227.69	1	21
casket leg	60	1897.227.66	1	18
casket leg	61	1897.227.72	1	24
casket leg	62	1897.227.73	1	25
casket leg	63	1897.227.74	1	26
casket leg	64	1897.227.75	1	27
embossed strip	65	1897.226	1	4
embossed strip fragment	65	1897.226.76 A	1	71
embossed strip fragment	65	1897.226.76 B	1	71
embossed strip fragment	65	1897.226.76 C	1	71
embossed strip stud	65	1897.226.76 A	1	71
embossed strip fragment	65	1897.226.76 D	1	-
embossed strip fragment	65	1897.226.77A	1	72
embossed strip fragment	65	1897.226.77B	1	72
embossed plaque	66	1897.226.77	1	64 (x2)
embossed plaque	66	1897.226.77	1	64
embossed plaque	66	1897.226.77	1	64

Table 8. 5: Table listing casket fittings from the hoard.

Drop handles

Figure 8. 48: Three different types of drop handle from the hoard; (1897.227.63/62/64: MS 50; 52; 53).

The single larger drop handle (1897.227.63: MS 50) (figure 8.48) is relatively finely made and moulded; the unleaded brass from which it was made is quite pure with no tin and negligible lead levels (figure 8.52; 8.53), and was perhaps more carefully chosen than the alloys used for the smaller, plainer handles, which are leaded bronze or leaded gunmetal (figure 8.52; 8.53). The large handle is similar in style and composition to those found with the gaming board in the 'Warrior's' burial at Stanway; here the authors suggest they were probably of continental origin and although usually associated with boxes, there is growing evidence for a wider variety of uses (Crummy *et al*. 2007 187-8, 337). The smaller handles could possibly have been used on vessels (Spratling 2009, 74).

Casket legs

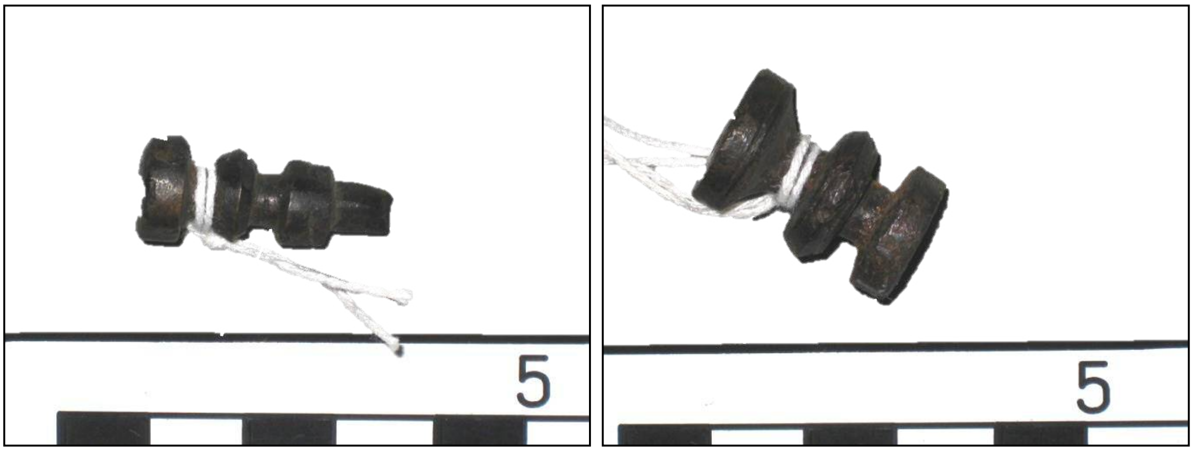


Figure 8. 49: Examples of the two forms of cast casket legs (1897.227.68/75: MS 57; 64).

Spratling believes that all the drop handles and the casket legs were new when buried (Spratling 2009, 74). He divides the two sets of five casket legs into further groups, with a set of four amongst the finer ones (figure 8.49) (1897.227.67-71: MS 55-59), which are all bronze and of very similar composition (figure 8.52), with bronze tangs for attachment, and two pairs of the thicker examples (figure 8.49) (1897.227.66, 72-75: MS 60-64). The latter group have iron tangs, and although they are made from leaded bronze, which is more difficult to analyse accurately due to segregation of lead within the copper tin alloy (figure 8.53); all five of these legs also appear similar in both major and trace metal content (Figure 8.52-8.54). MS 57 and MS 60, which Spratling regards as single items within the two sets (*ibid*) show no marked difference in composition to the others in each set, and it appears that as far as their manufacture is concerned, there are two discrete groups of five legs each.

Embossed strips

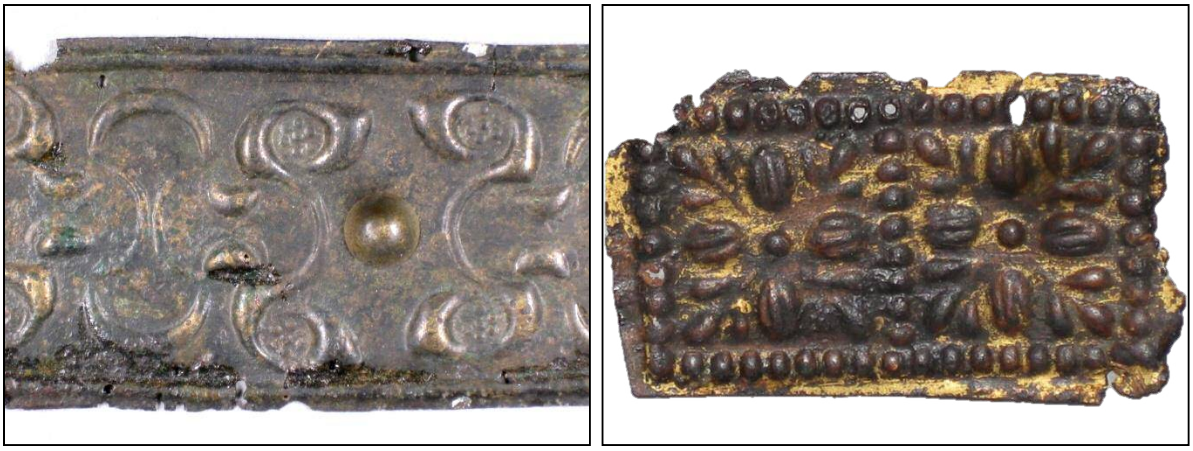


Figure 8. 50: Decoration on an example of the embossed strips and on the small plaques (1897.226: MS 65; 1897.227.77B: MS 66).

The several fragments of decorated strip with curvilinear design, which survive in a variety of completeness, appear to belong to the same object, as the embossed pattern would suggest (figure 8.51). The slight difference visible in their compositions is likely to be a result of their surface condition; the two fragments 1897.226.77 A and B, which have a more metallic coloured surface, show a very slight variation in the scatter diagrams to the other examples (figure 8.52; 8.53).

Figure 8. 51: Two fragments of the decorated strips (1897.226.77B, and 1897.226.76C: MS 65): showing differences in the condition of their surfaces.

The three small plaques are unusual (figure 8.50), as they are the only pure copper objects in the hoard (figure 8.52; 8.53). The relatively soft metal would make them easy to emboss, and the design is relatively unsophisticated, displaying a more ‘geometric’ pattern.

All these plaques were probably originally attached to a wooden object, probably a box rather than a bucket or tankard as there is no evidence of any curvature of the metal. The repetitive motifs would have been embossed on to the reverse of the metal strip or plaque using a stamp or die not dissimilar to those from within this hoard (1897.227: MS 6-7, figure 8.35). This process would have resulted in the relatively rapid production of design elements, and these deliberately mass produced objects differed from the manufacture of the majority of earlier Celtic art (excluding coins), which seemed to strive to create unique or one off pieces (Garrow and Gosden 2012).

Although there are some relatively early examples of stamp pressed designs, produced on the buckets from Aylesford, Marlborough and Baldock (Macdonald 2007, 150); the majority of similar plaques seem to be first century AD examples of ‘geometric’ Late Iron Age art (although the strips and one of the cast stamps (1897.227.7: MS 7) are slightly unusual in showing distinct curvilinear elements within their repeatable motifs). In many respects the stamped design technology of the embossed metal plaques and strips echoes that of incoming ‘piece’ moulds, such as those from Prestatyn (Blockley 1989) rather than the use of labour intensive ‘investment’ mould technology. Both these more recently adopted techniques allowed easier reproduction of near identical objects, many of which were relatively small and mundane or domestic in nature, compared to the high status weaponry, horse fittings and communal feasting or drinking attire often associated with high status decorated Iron Age metalwork. It is for these reasons that such embossed plaques have been pejoratively labelled as ‘tourist’ art (Megaw and Megaw 1989, 230). The slightly ‘Romanised’ geometric form of the designs ‘can be considered as analogous with the production of military fittings of native style by British craftsmen for elements of the Roman military’ (Macdonald 2007, 149). As with the examples from Llyn Cerrig Bach, the trace element analysis of the strips and plaques shows a low arsenic content within the bronze (figure 8.54), which is often associated with Roman rather than Iron Age metal working traditions (Macdonald 2007, 151; 204-5; Dungworth 1997, 6.6.3).

Metallurgical analysis of casket fittings

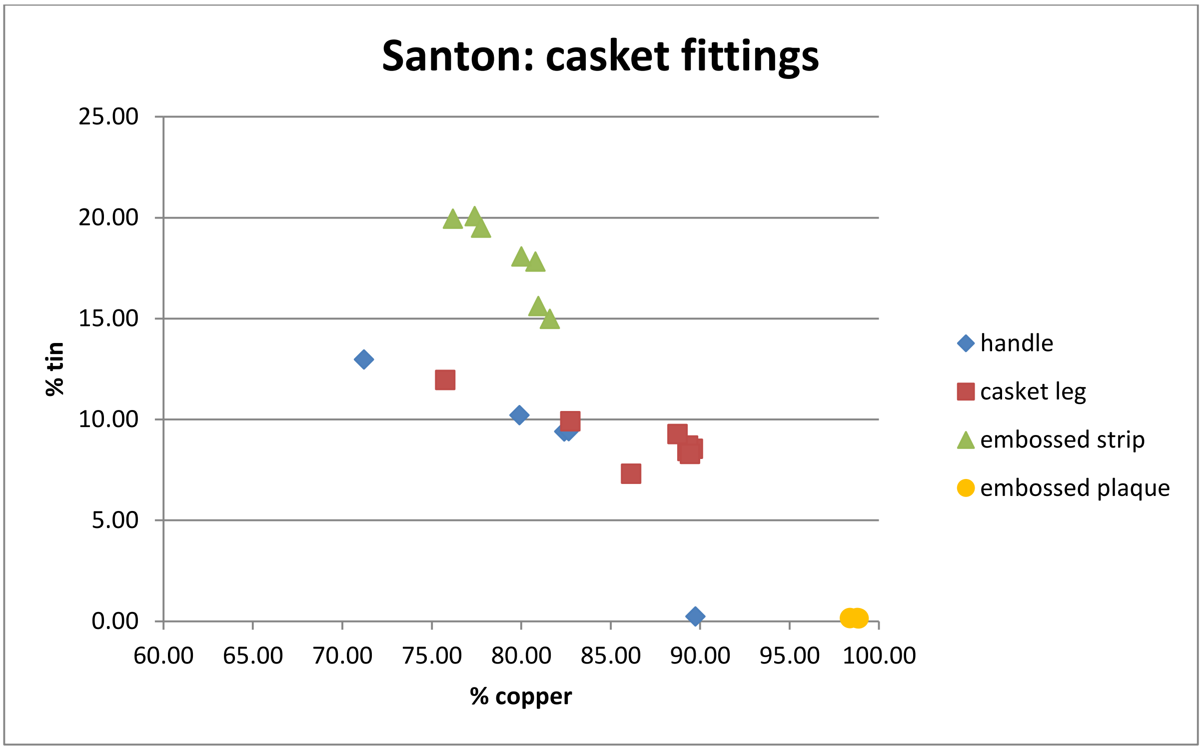


Figure 8. 52: Scatter diagram showing the copper and tin content of the casket fittings.

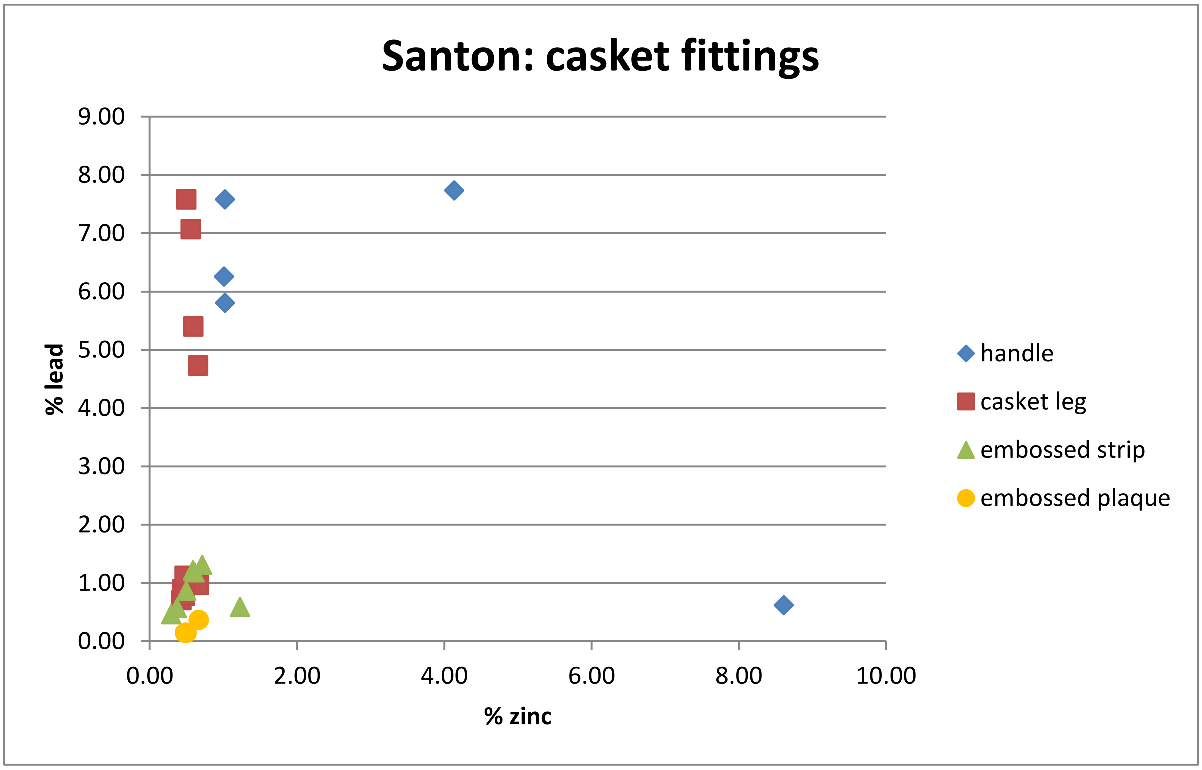


Figure 8. 53: Scatter diagram showing the zinc and lead content of the casket fittings.

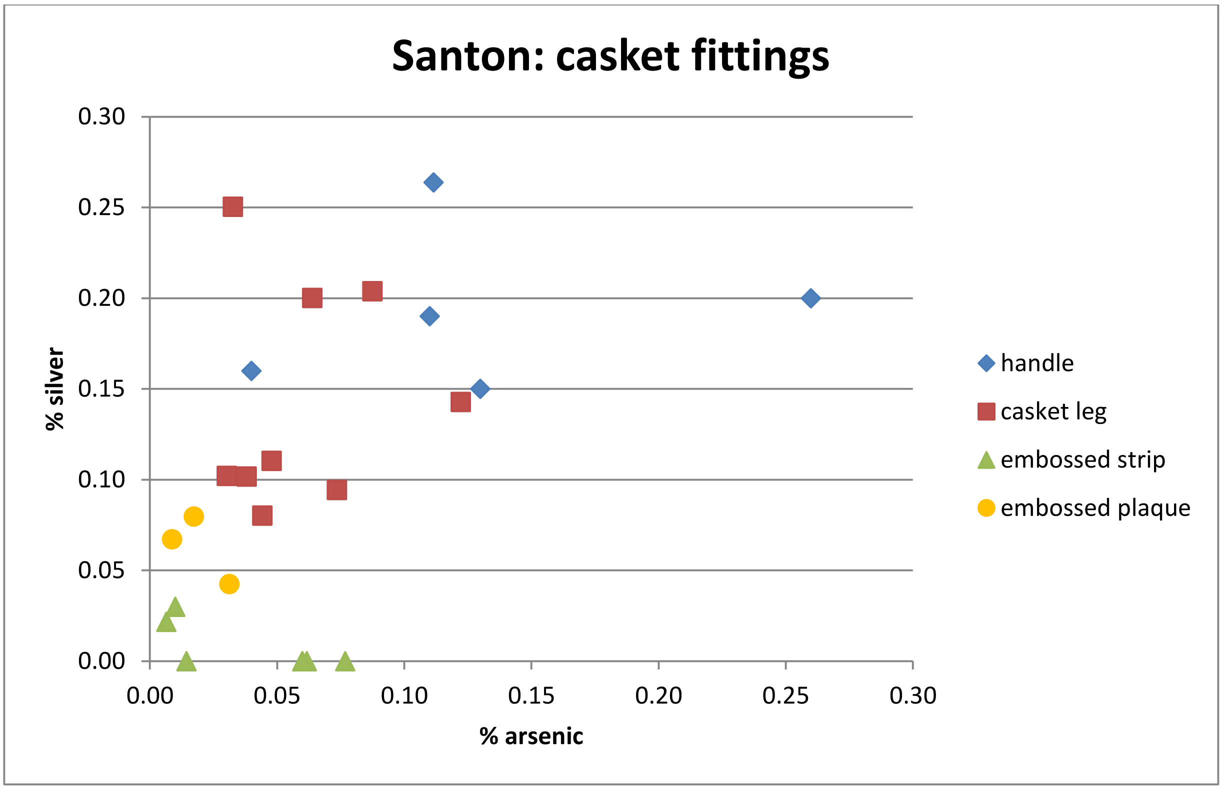


Figure 8. 54: Scatter diagram showing the arsenic and silver content of the casket fittings.

Many of the casket fittings appear to represent a cross between 'geometric' Late Iron Age insular art, and the development of Romano-British style artefacts; the handles appear to be of Roman design (Spratling 2009, 74). Small decorated boxes or containers seem to occur after the Roman invasion, and as stated above, could be associated with the presence of the Roman military and its attendant entourage. They particularly show the trait of relative mass fabrication, illustrated here by the production of sets of identical casket-legs, plaques and handles. In contrast to the brooches, all the casket legs and handles look newly made (Spratling 2009, 74).

Armour fragments (lorica segmentata)

Object type	MS	number	fragments	Analysis number
lobate hinge	76A	1897.227.89	1	9
rectangular hinge	76B	1897.227.87	1	79 (x2)
double hinge	76C	1897.227.88	1	80

Table 8. 6: Table listing *lorica segmentata* fragments from the hoard.

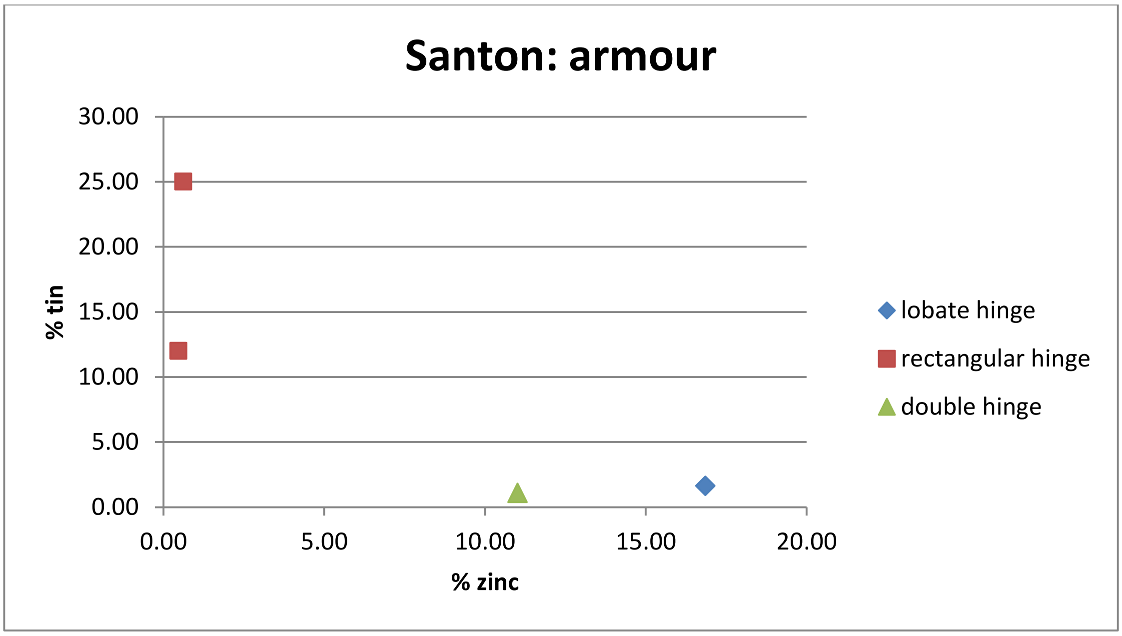


Figure 8. 55: Scatter diagram of zinc versus tin for the armour fragments.

The scatter diagram of the armour hinges (figure 8.55) shows that the lobate and double hinge are brass, whereas the rectangular hinge is bronze and tinned on one surface (figure 8.56). The latter also contains small but significant quantities of lead which would have helped in the casting process.

Figure 8. 56: Three armour hinges from *lorica segmentata*: lobate hinge (1897.227.89: MS 76A); rectangular hinge (1897.227.87: MS 76B); double hinge (1897.227.88: MS 76C).

These are all recognisably Roman pieces of military equipment, and their distinct appearance and associations could imply their presence and status within the assemblage was as looted material during a successful military engagement (Spratling 2009, 74). The distinctly Roman pieces of armour are paralleled in the Seven Sisters hoard where Roman military horse fitting were included. Within both these hoards the Roman military nature of the objects stands out against indigenous or traded imported material.

Other copper alloy items

The list of objects in table 8.7 have been difficult to categorise or interpret; most appear to be fittings of some kind or other. The items in this category are either leaded bronze or brass. In figure 8.57, the leaded bronze objects run along the Y axis; the second readings for the same objects with both low lead and zinc values (lower left hand side of graph), are readings taken from the tinned surfaces of the same objects: two rounded tinned objects (1897.179: MS 45 and 1897.227.48: MS 46) (figure 8.59), and a tinned washer (1897.227.80: MS 69) (figure 8.60). The lower lead levels are because the XRF beam would not penetrate the tinned surface to analyse the composition of the metal substrate.

The baluster ferrules (1897.227.31/30: MS 29-30) (figure 8.58) and the domed ferrule (1897.220.85: MS 74) (figure 8.60) are relatively pure brass, and their colour would have been distinctly golden in colour, and thereby, as with the tinned items, probably had some decorative function to match any practical use.

Object type	MS	number	fragments	Analysis number
baluster ferrule	29	1897.227.31	1	17
baluster ferrule	30	1897.227.30	1	16
rounded tinned object	45	1897.179	1	70
rounded tinned object	46	1897.227.48	1	83
decorated washer/ring	69	1897.227.80	1	61 (x2)
domed ferrule/cup	74	1897.220.85	1	51
ferrule	75	1897.220.86	1	82

Table 8. 7: list of 'other' uncategorised objects from the hoard.

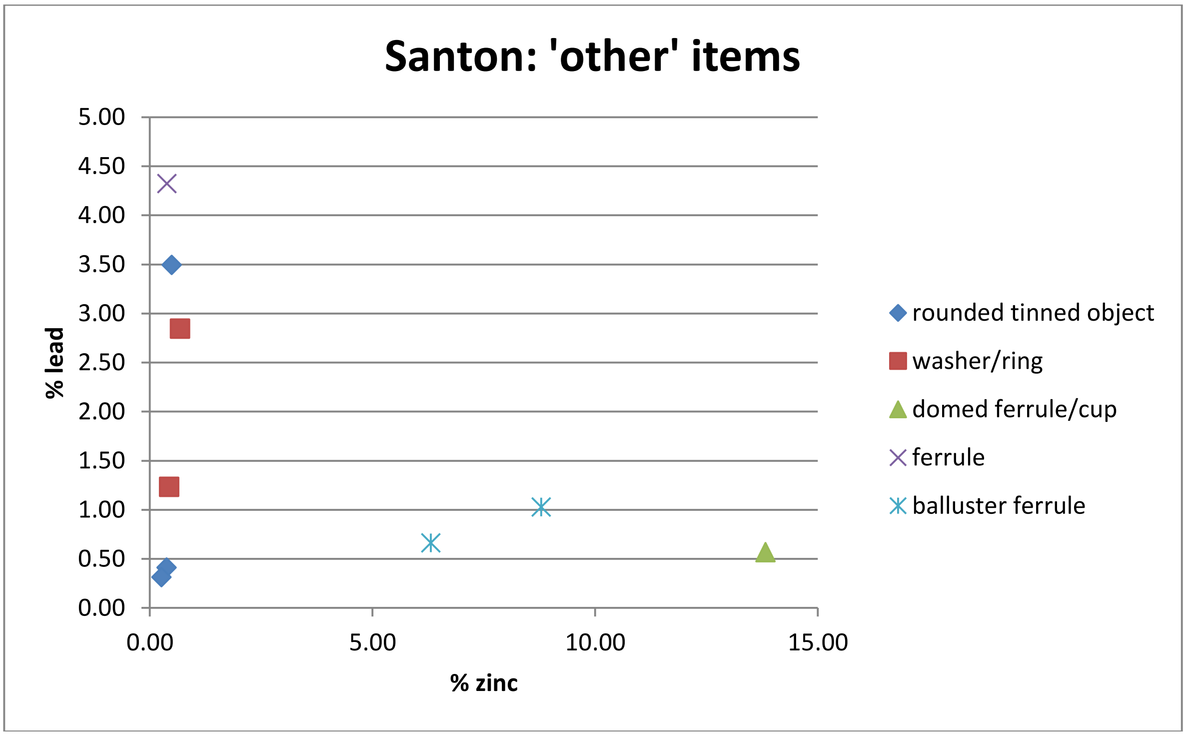


Figure 8. 57: Scatter diagram of zinc versus lead for 'other' items in the hoard.

'Baluster Ferrules' (1897.227.31 & 30: MS 29 & 30

Similar objects to the 'baluster ferrules' (figure 8.58) have been found in eastern England in the Westhall and Colne Fen hoards and at Colchester (Spratling 2009, 29, 75); their function is unclear, they have been described as linch pins, but the fact they are open at both ends makes this definition unlikely (Spratling 2009,29)

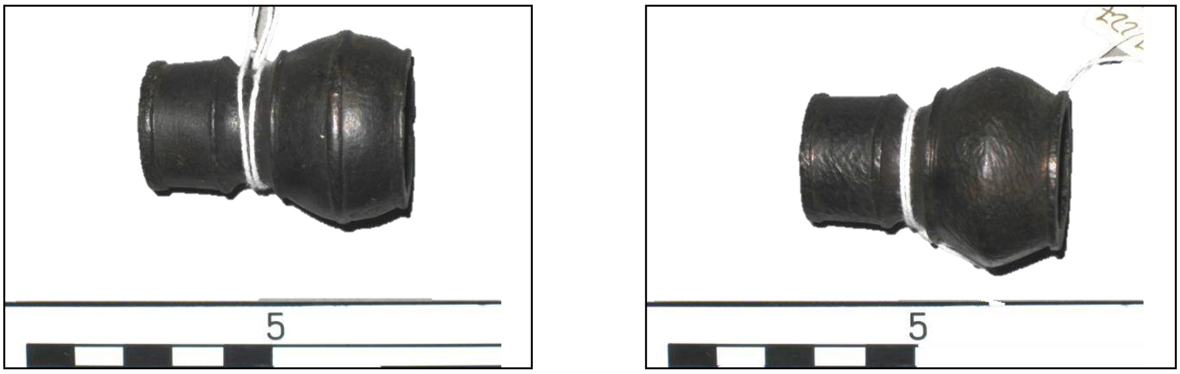


Figure 8. 58: 'Baluster ferrules' (1897.227.31 & 30: MS 29 & 30).

Tinned object fragments 1897.179: MS 45 & 1897.179.48: MS 46

These domed tinned objects were categorised as bowls (i.e. vessels) by Spratling (2009, 39); however, the carefully turned in lower edge present on the more complete example (1897.179: MS 45) suggests there was no base, and so infers these objects were probably some sort of fittings rather than vessels (figure 8.59). Although tinning is relatively rare on Late Insular La Tène; there are some notable exceptions. In north Wales tinned objects were found in both the Tal y Llyn and Moel Hiraddog assemblages (Savory 1976).

Figure 8. 59: (1897.179: MS 45) outer and inner views of object, plus detail of carefully turned in lower edge.

Figure 8. 60: domed ferrule/cup (1897.220.85: MS 74); ferrule (open at both ends) (1897.220.86: MS 75); decorated washer/ring (1897.227.80: MS 69).

Scrap metal pieces

Many of the scrap vessel sheet fragments quite clearly come from several different copper alloy artefacts, seen not only by their composition (figure 8.61) but also their surface finish (figure 8.63; appendix 6)

Object type	MS	number	fragments	Analysis number
arcaded folded sheet	77	1897.227.92A	1	66
folded sheet	78	1897.227.97A	1	75
cut sheet	80	1897.227.93	1	66
scrap sheet	81A	1897.227.92AD	1	66
scrap sheet	81B	1897.227.92H	1	66
scrap sheet	81C	1897.227.92AE	1	66
strip	82A	1897.227.95A	1	86
strip	82B	1897.227.95B	1	86
scrap sheet	83	1897.227.92AB	1	66
vessel sheet fragment	84	1897.227.92 (A-AF)	27	66
bent bar	85	1897.227.98	1	76
curved bar	86	1897.227.96A	1	81
bent strip	87	1897.218-28.100	1	55
coiled strip	88	1897.227.101A	1	63
metal lump	89	1897.227	1	56
hammered strip	-	1897.228.40B	1	44
scrap sheet	-	1897.228.90	1	53
metal lump	-	-	1	57

Table 8. 8: Table showing scrap metal pieces from the hoard.

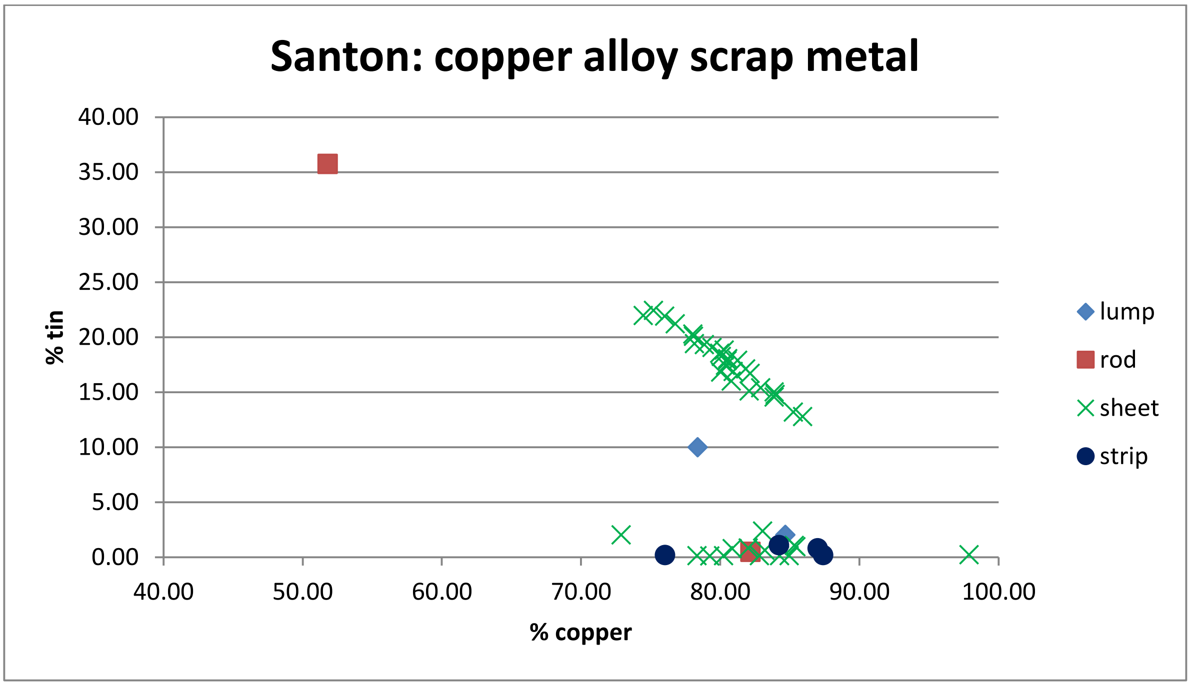


Figure 8. 61: Scatter diagram of copper and tin showing different types of scrap copper alloy from the hoard.

The scraps are predominantly made from brass and bronze (figure 8.60), but some are also leaded gunmetal and there is one piece of leaded brass (figure 8.61). It can be seen that the composition of the lumps and rods (of mixed metal composition), and strips (brass) are mostly different to that of the sheet fragments.

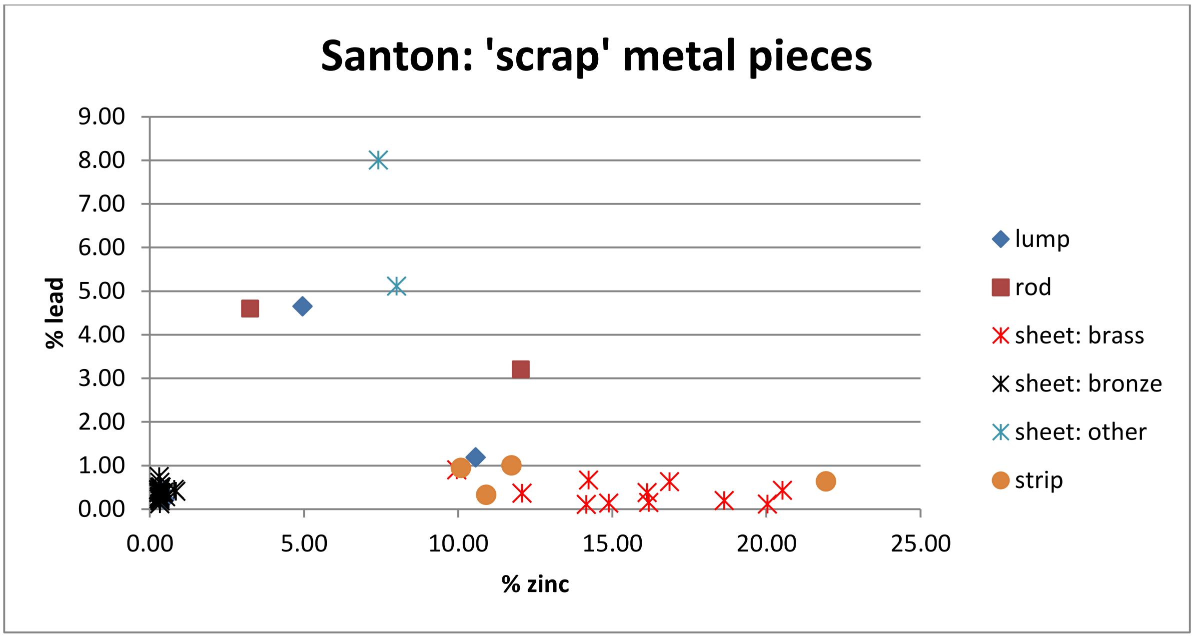


Figure 8. 62: Scatter diagram of zinc and lead of scrap copper alloy from the hoard. The strips of metal are predominantly brass; rods and lumps are more mixed alloys.

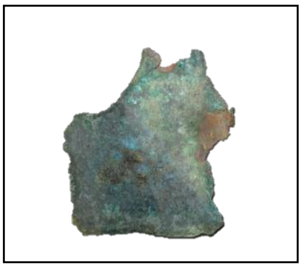


Figure 8. 63: Three pieces of scrap metal made from: tinned bronze (1897.227.92U); brass (1897.227.92I) and leaded gunmetal (1897.228.90).

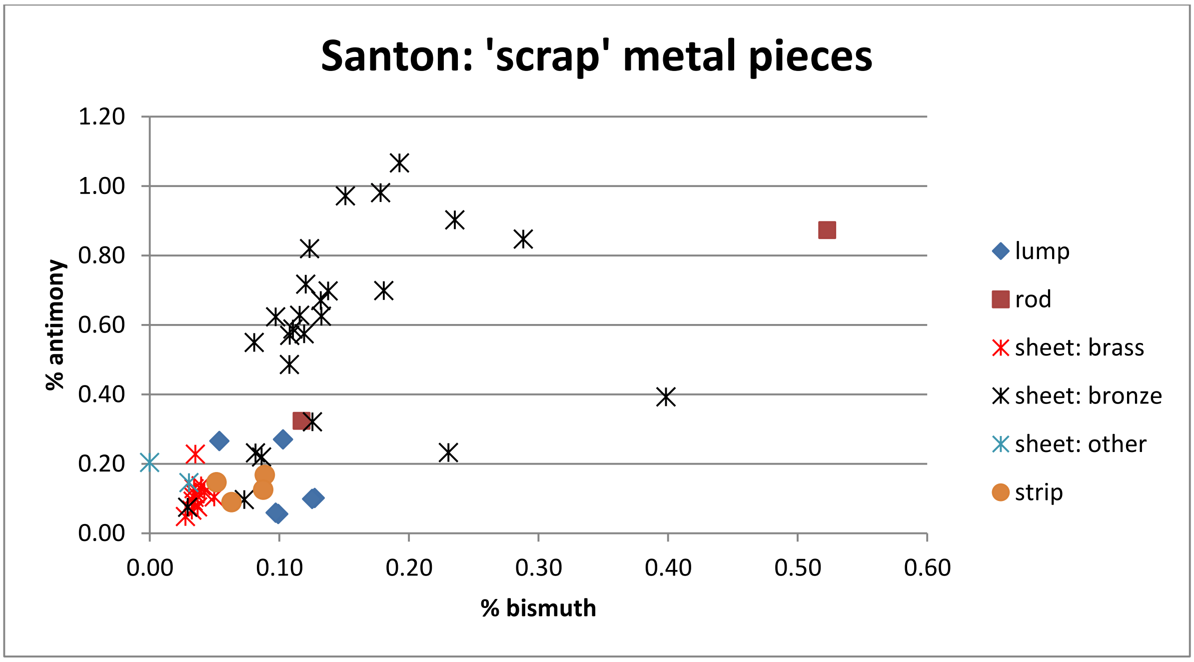


Figure 8. 64: Scatter diagram of bismuth and antimony of scrap copper alloy from the hoard.

Trace element analysis of the scrap pieces show that the bronze sheet fragments nearly all contain more bismuth, and more antimony than the brass sheet fragments, which contain very little of either element. Distinct groups of objects and their compositions can be distinguished, and with further analysis it might prove possible to try to determine the number of vessels from which the scrap pieces are derived. The sheet brass looks relatively similar in composition on the above scatter diagrams (figure 8.61; 8.62; 8.64), but the bronze fragments are less alike, especially for trace element analysis (figure 8.64).

Other Materials

Iron, glass, lead and bone items, as well as a piece of rosin were also present; although objects made of materials other than copper alloy are present in other hoards, these tend to be relatively uncommon, for example the small collection of iron objects from Polden Hill (a lynch pin, toggle and rod; appendix 4). Within the Santon hoard there are many fragments of iron, including a pair of tongs, although most of the other pieces are not easily interpreted without X-radiography; similarly there were 'between sixty and seventy lumps of corroded iron' in the Stanwick/Melsonby hoard (MacGregor 1962, 52). A proportion of the latter have since been interpreted as hoops and band fragments from stave-built vessels (Fitts *et al*. 1999, 40-43), amongst many less diagnostic fragments and scraps. It is possible there are also further vessels with iron components from Santon.

Discussion of hoard and contents

This hoard is so varied that as a whole it is difficult to categorise easily and therefore has largely been discussed in sections. It has many similarities with other Late Iron Age hoards, but also some fundamental differences, probably reflecting the rather ambiguous political and geographical situation of the Iceni in the mid-first century AD.

The graph below (figure 8.65) illustrates how diverse both the content and style are within the Santon hoard; the degree of variability makes a much less closely defined picture of artefact, style and metal use than seen in the contemporary western and northern hoards.

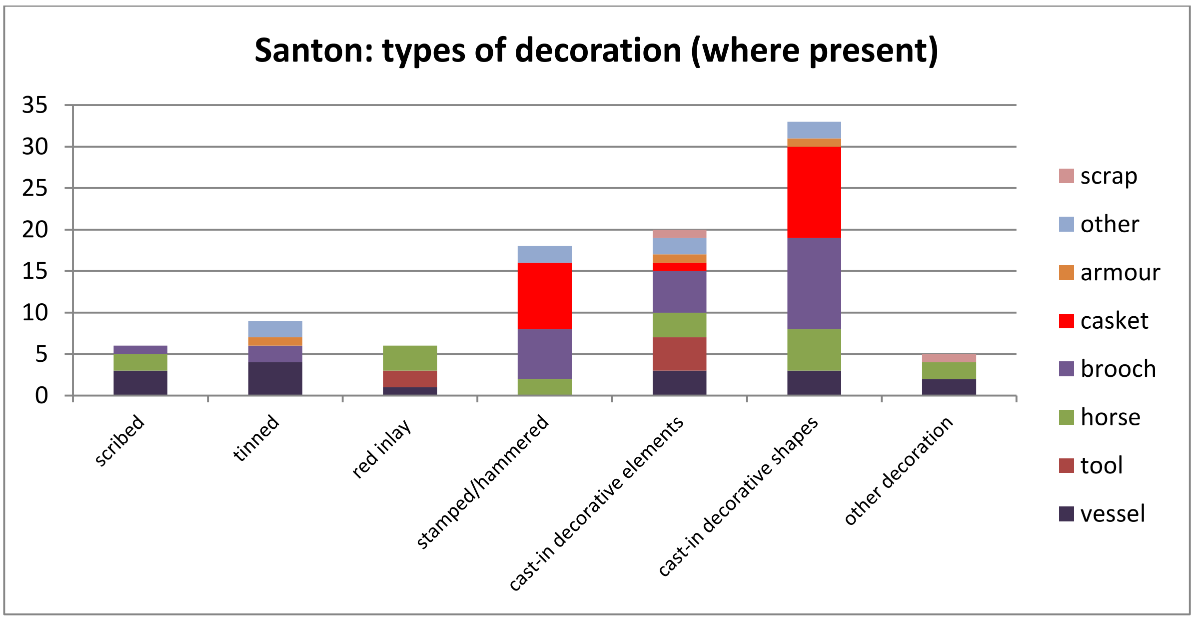


Figure 8. 65: Object type and decorative techniques used on objects from the Santon hoard.

Continental and indigenous influence

One significant way in which this hoard differs from the other Late Iron Age examples, is that a proportion of its contents were imported from the continent (and/or copied from continental types). In south east Britain artefacts of similar origin are seen in Welwyn type cremation burials dating from the late second and first century BC, with the tradition continuing into the first century AD for burials such as those from Folly Lane (Niblett 1999) and Stanway (Crummy *et al.* 2007). The form and composition of items within these later cremation burials, as well as showing continental influence, also demonstrate influences from the developing 'Insular La Tène' metalwork tradition which seemed to develop rapidly after a possible hiatus of manufacture or deposition at the turn of the first millennium BC-AD (Garrow & Gosden 2012, 29). Like the first century AD burials, material from Santon seems to show a complex mixture of material culture affiliations in the hoard; in many ways this directly reflects foreign contacts and trade, but also the uneasy Icenian relations with Rome and south eastern England from the time of Caesar's invasions in 55 and 54 BC to the Claudian invasion in AD 43, and the Boudican AD 60/61 uprising (chapter 3).

Although a complex hoard to interpret, the Santon hoard also provides a good foil in discussing the diversity and connections within society in Britain in the first century AD. Geographically, continentally influenced material culture from adjacent 'tribal' areas were inevitably significant and accessible; but indigenous Late Iron Age themes associated with feasting and drinking are also present. The addition of some horse-related equipment within the hoard makes this particular point, especially with the inclusion of quadrilobed strap unions with curvilinear decoration. These large decorated items were so spectacular in their own right that they gained currency throughout Britain, but the two-link bridle-bit is unusual in eastern England. The Icenian predilection for horse and harness equipment (also found at Soham Toney and Westhall), emphasises a strong indigenous cultural link by the presence of such objects in these hoards.

The use of leaded alloys for artefacts (other than brooches) within the hoard reflects the continental use of copper alloys (Hamilton 1996; Brun and Pernot 1992, 249) in comparison to the indigenous 'insular art' traditions exemplified by non-leaded copper alloys used for high-status objects found in the western Late Iron Age British hoards. The particular use of non-leaded copper alloys upholds the argument for the employment of certain materials and art traditions as intrinsically significant to the production of focal items of indigenous material culture. This must have been important for those both making and using the objects, as a means of consolidating their identity either actively or passively, in resistance to Rome. This point is noted by a further subtle difference for certain particular items in the Santon hoard; the horse equipment here (strap unions and bridle-bit) contains lead, which is the exception rather than the rule for similar pieces of horse equipment made in investment moulds; lead would make manufacturing easier, but was normally avoided. The role of the craftsmen in such circumstances should also therefore be seen as significant; a layman would probably not be able to register a small but significant amount of lead used to aid casting technology; (as with the Santon quadrilobed pieces); but the metalworker had it within his authority and knowledge to choose carefully what alloys were used, and unusually in this instance, chose the practical addition of some lead, rather than the deliberate and possibly symbolic exclusion of this metal.

A further important category within this hoard which reflects a change in metal use is the brooch. South eastern England was probably the first part of Britain to import brooches made of brass; and these would certainly have stood out by their distinct colour in contrast to bronze or iron. They could have been used to signify affiliations, contacts and trade networks, openly denoting European continental connections, and therefore were potentially powerful emblems. One piece brooches were nearly all made of bronze or brass (Bayley and Butcher 2007, 148 fig 110) and this reflects technological practicalities, as leaded copper alloys are not particularly good for the manufacture of wrought items. However, the use of either relatively pure brass or pure bronze was continued after the Roman conquest both on the continent and in Britain for some cast brooches (Dungworth 1997 7.1). Within the Santon hoard, several leaded bronze brooches are present, which represents a different and far less selective use of metal, and coincides with the introduction of the use of piece moulds in Britain. This enabled the production of multiple copies rather than of one off items, very different to the pattern of indigenous metal working seen for most artefact types within the Late Iron Age hoards, where a unique one-off quality was favoured. The addition of lead, notably present on some British made brooches, not only made casting distinctly easier, it also helped to make the bronze or brass go further, and therefore such items were both cheaper and easier to make.

Graves versus hoards

Garrow and Gosden, in their discussion of the Welwyn-type burial from Baldock in Hertfordshire state 'it almost seems inappropriate to talk about it as a burial; in many ways, it shares more similarities with a hoard' (Garrow and Gosden 2013, 247). This is an interesting remark in that without some of the objects, especially the large amount of scrap metal, the items within the Santon deposit could seem to be reflecting those of rich Late Iron Age burials in south east England.

Santon contains many artefact types in common with first century AD graves, for example those at Stanway (Crummy 2007) and Folly Lane (Niblett 1999), and this has lead to increasing speculation as to whether it was originally a cremation grave; indeed Spratling comes to this conclusion (2009, 76-78). There are, however, along with some similarities, a number of significant differences, which Spratling acknowledges, but which lend weight to this deposit being a hoard.

Graves, such as those found at Stanway or Folly lane are carefully laid out in prepared pits or enclosures. Crummy sums up 'the funerary aspect of the Stanway site' as characterised by ' large funerary enclosures, timber mortuary chambers, cremation burials, pyre sites, small ditched areas ...pits with pyre debris...and smashed pots in ditches' (Crummy, P. 2007, 423). Although the Santon site did not undergo a level of excavation which might clarify the presence or absence of such features; there is little written evidence that any of them were present.

All the objects were apparently found within a large cauldron (Spratling 2009, 72); in this respect the hoard is similar to that from Westhall (Harrod 1885), which mainly contained horse trappings. This seems to differ significantly from 'burials of the Late Iron Age and Roman periods, [where] the vessels were laid out face upwards in the graves with almost no nesting of one within another' (P. Crummy 2007, 429). It also fits in with other deposits such as Carlingwark (Manning 1972), where the cauldron is a convenient container for the hoard, but also draws on the importance of cauldrons in the context of consumption; if hoards are in part meant to be offerings, then the material within could be seen to be offered for consumption too (Joy pers. Comm.).

Related to the point above, is that there is no evidence of a grave cut at Santon; many of the graves from this period show careful consideration in terms of space and positioning of objects within the grave, which was probably of significance and importance during ceremonies or rituals associated with the interment of the ashes (Wells 2012). Items from the Santon hoard do not seem to have been ‘placed’ in a constructed burial scene – see Wells. There are also no reports of ‘other’ adjacent burials at Santon; and it lies outside the main area of the richly furnished graves seen in the burial tradition of eastern England (figure 8.66).

Another major difference between a hoard and a burial in this context is the many fragmentary and partial objects; there are a considerable number which are broken and incomplete, and not because they have been partially destroyed by a funeral pyre. The complex collection of such a variety of objects in the Santon hoard do not appear to complement each other to the same level as many south eastern grave assemblages such as the ‘Warrior’s’ or the ‘Doctor’s’ burial from Stanway (Crummy *et al.* 2007).

No ceramic objects are preserved as part of the Santon hoard; although Spratling does refer to pre-Roman Iron Age pottery sherds found within its vicinity (Spratling 2009, 3). There are also no extant human remains; but this negative evidence has to be viewed with caution, as there is a report that human bones were found by the cauldron (Spratling 2009, 76). It is also clear that sometimes very little of the original cremated body ended up in the grave; this has been noted for the Baldock burial where the extant ashes probably represented less than 2% of the cremated remains of an adult (Garrow and Gosden 2012, 242).

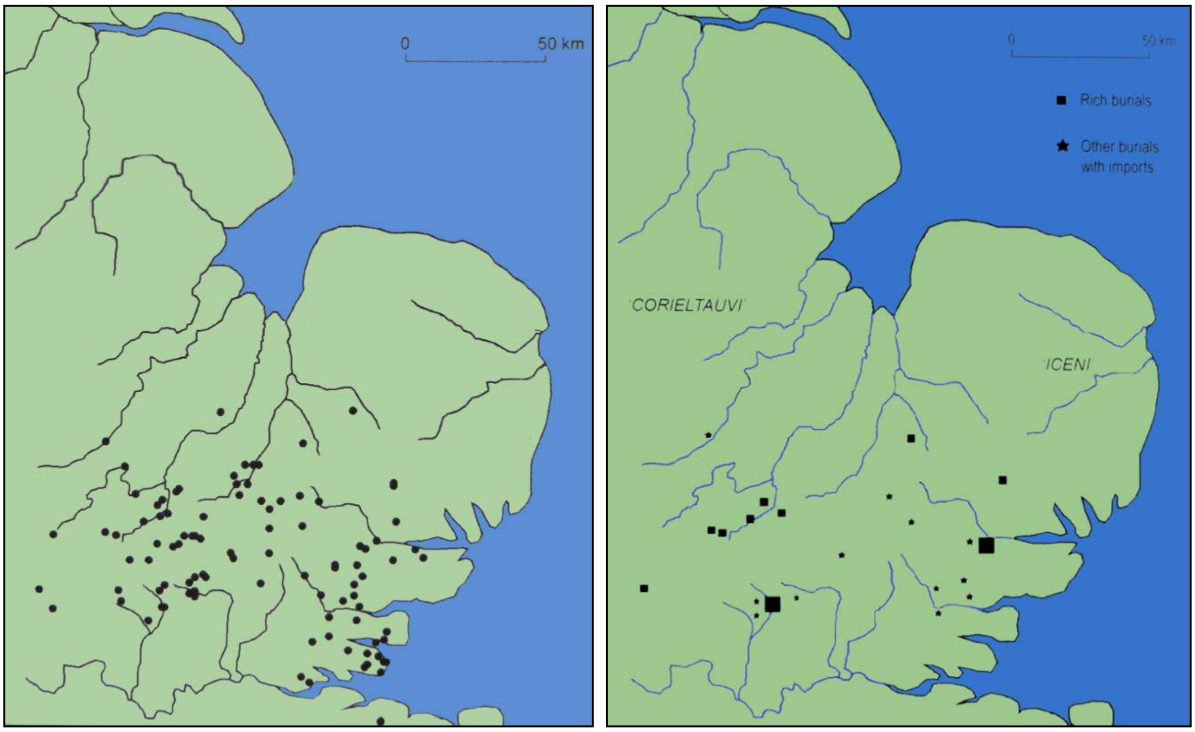


Figure 8. 66: Distribution of pre-Roman cremation burials of the first century BC and first century AD in Eastern England (after Hill 2007, 28); distribution of ‘richly furnished’ cremation burials in eastern England c.20-10BC to AD 50-60 (after Hill 2007, 33).

Spratling’s conviction that this is a burial rather than a hoard could be a difficult distinction to untangle; there are both similarities and differences; Santon is near the edge of a territory where both hoarding and burial were practiced. This merging and ambiguity could reflect Late Iron Age as well as modern ambivalence. The complimentary deposition of hoards and burials in time and space in the Iron Age (Hunter 1997); and even in the types of deposit (Hunter 2014), imply different cultural practices when dealing with significant events within communities, but with many aspects in common: such as burning the artefacts (implicated in Polden Hill, Seven Sisters and Stanwick and possibly Westhall); the types of objects buried (vessels, horse equipment, brooches, tools etc); and the fact that they were buried in the ground in a single episode all imply a deliberate amalgamation during different burial practices – whether bodies, artefacts or both.

It is possible to equivocate and argue here that for the Santon hoard; the distinction in this particular time and place in Iron Age Britain was becoming blurred and merging in some fundamental respects in thinking and practice.

Chapter 9. The Middlebie Hoard

The Middlebie Hoard was discovered in Dumfries and Galloway; the original report on 'Donations to the Museum' noted in PSAS states that it comprised 'Two bronze bridle-bits and twenty-seven pieces of Harness Mountings of "Late Celtic" type, one enamelled, found in a moss at Middlebie, Annandale in 1737' (PSAS 28 237). It is now housed in the National Museums Scotland.

This region in south west Scotland was probably within the territory of the Novantae. Relatively little is known about this tribe in the first century AD. Agricola appears to have led a concerted campaign in AD 80 into south east Scotland, taking the twentieth legion north east from Carlisle (Salway 1981 144), and in AD 81 this area was consolidated, possibly in preparation for an intended campaign into Ireland the following year, which did not take place (Tacitus Agicola 24).

MacGregor notes that even after the construction of Hadrian's wall, and later the Antonine wall - which brought the southern Scottish tribes (Votadini, Damnonii , and Novantae) within the Roman province, that 'Roman finds are plentiful in the crannogs of the Damnonii and on Traprain Hill, [but] scarce in those areas occupied by the Novantae and Selgovae' (Macgregor 1976, I 20). However, there are a number of significant Iron Age finds from the area.

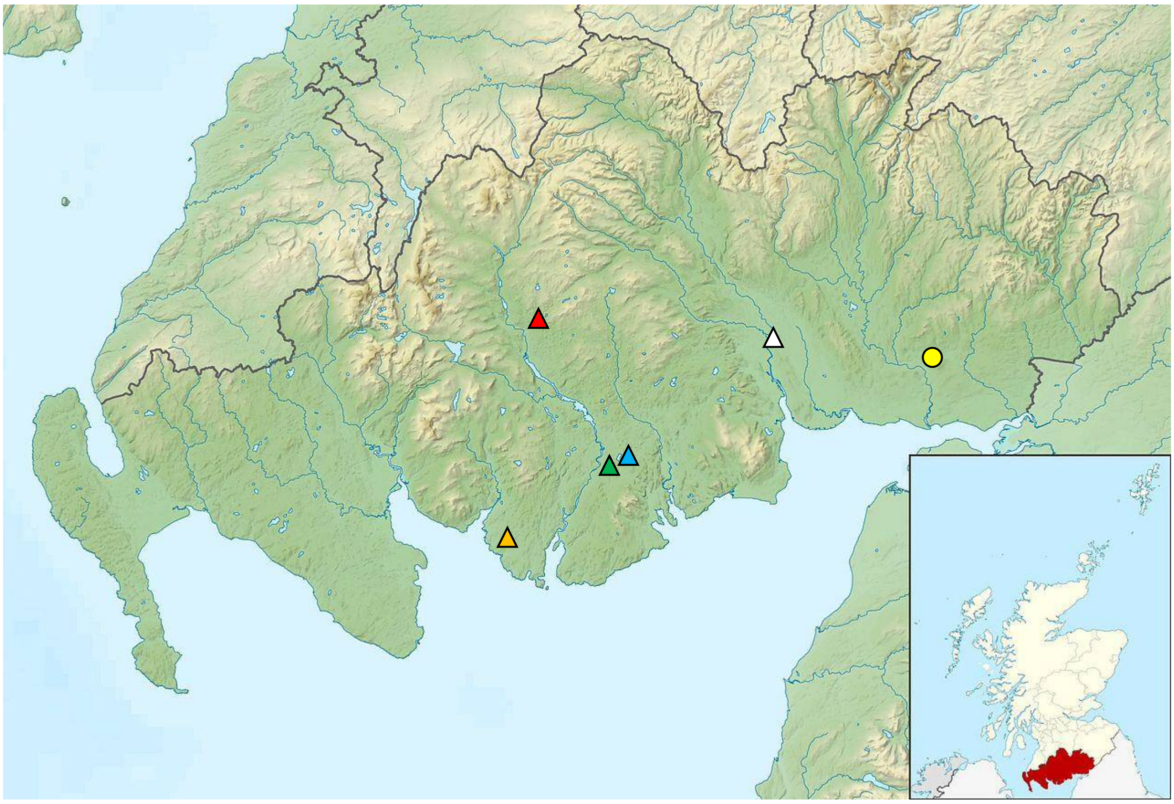


Figure 9. 1: Location of Middlebie (yellow circle), and other Iron Age finds within Dumfries and Galloway; Lochar Moss torc (white); Carlingwark hoard (blue); Torrs chamfrein (green); Balmaclellan mirror and decorated copper alloy strips (red); Castle Plunton bracelet (orange). http://upload.wikimedia.org/wikipedia/commons/e/e2/Dumfries_and_Galloway_UK_relief_location_map.jpg

Objects from the Hoard

The hoard now consists of twenty seven objects, but originally had contained one further bridle-bit, apparently a pair to FA 71 (figure 9.27) (Macgregor 1976 II no. 6, after Wilson 1851 459; Macgregor 1976 II 2). As the statement of donation cited above affirms, almost all of the pieces are directly associated with horse and chariot equipment; the notable exception is the hilt guard. Some of the strap fasteners, including the button and loop fasteners could arguably be for use on clothing rather than horses, but the contexts of many such objects, including those in the Middlebie hoard, imply they were for decorative harness equipment of some kind (Macgregor 1962, 23; Wild 1970, 145).

OBJECT	NUMBER OF OBJECTS	OBJECT TYPE/GROUP
Terret	11	Chariot equipment
Bridle-bit	2	Horse equipment
Bridle-bit ring	4	Horse equipment
Strap union	5	Horse equipment
Strap fastener	1	Horse equipment/personal?
Button and loop fastener	3	Horse equipment/personal?
Sword hilt guard	1	Weaponry

Table 9. 1: Table of objects from the Middlebie hoard.

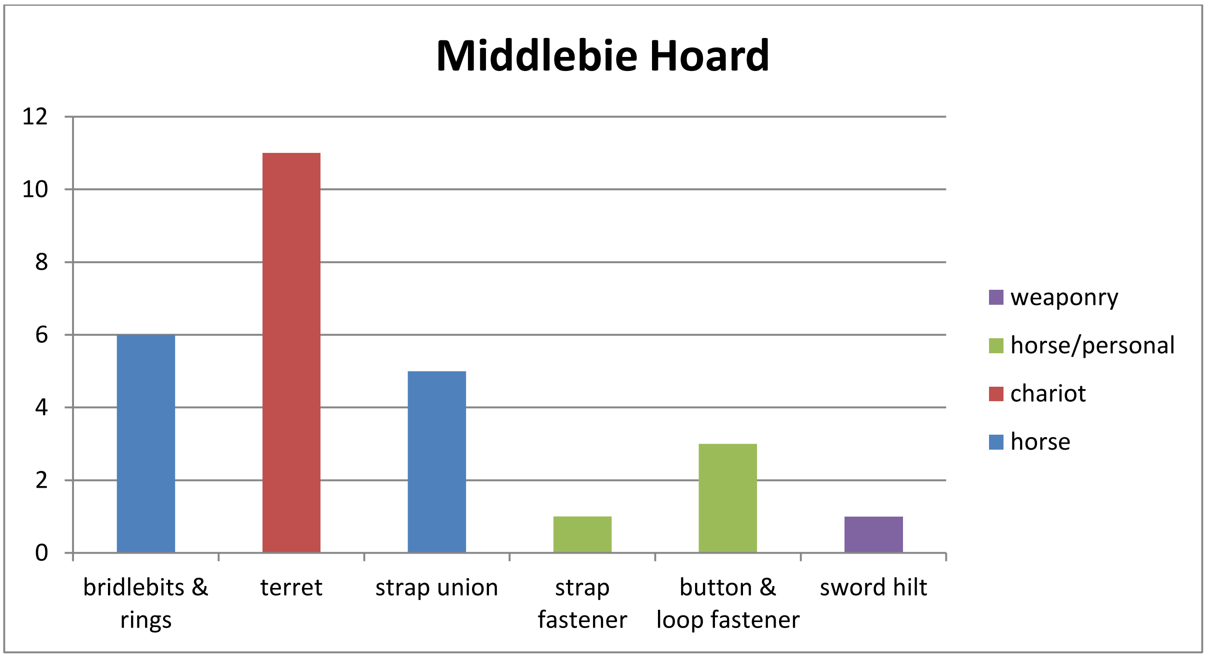


Figure 9. 2: Distribution of artefact type/use in the Middlebie hoard.

Metallurgical Analysis:

Analysis of the surface of the metal artefacts was carried out by X-ray fluorescence spectrometry (XRF) at the National Museums of Scotland; no sampling or polishing was undertaken, and although results were put through a quantification programme, the detail from any data has to be viewed with caution, due to factors such as surface corrosion, tin enrichment and de-zincification etc. However, the majority of the pieces had an even, lightly patinated metallic surface, rather than a significant corrosion layer (probably due either to burial in relatively anaerobic conditions in the 'moss', or to previous cleaning and conservation), and results from multiple readings were consistent.

Composition of the metal artefacts in the Hoard

The analyses were able to show some interesting patterns where the overall type of copper alloy could be assigned (bronze, brass, gunmetal etc), and where there were the consistent presence of trace elements on objects or groups of objects. From the results, the variable presence of elements was used to help group objects and assess them in relation to style within this hoard, and in reference to the analyses of other hoards. The use of surface XRF for objects from a hoard which are of roughly the same age and have been in identical burial (and museum) conditions does reduce the number of variables, so that readings that are consistent for one object or a group of objects can offer direct comparisons, and allow trends within the hoard to be assessed.

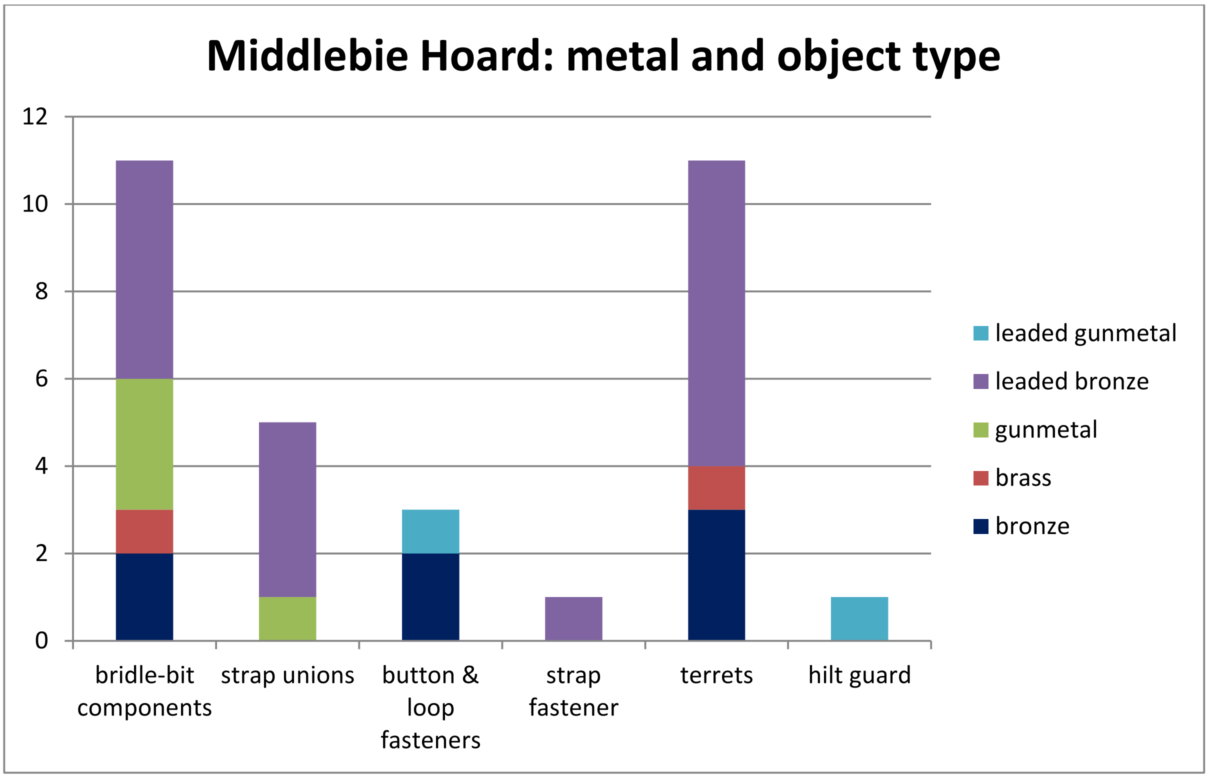


Figure 9. 3: Basic elemental composition of the hoard in terms of copper alloy type.

The majority of the objects from the Middlebie hoard are made from leaded bronze (figure 9.3); categorised as at least one percent lead detected within the alloy, although some objects contain considerably more. Although many of the objects are made from unleaded bronze, only seven contain significant quantities of zinc (two percent zinc or more), either as brass, gunmetal or leaded gunmetal.

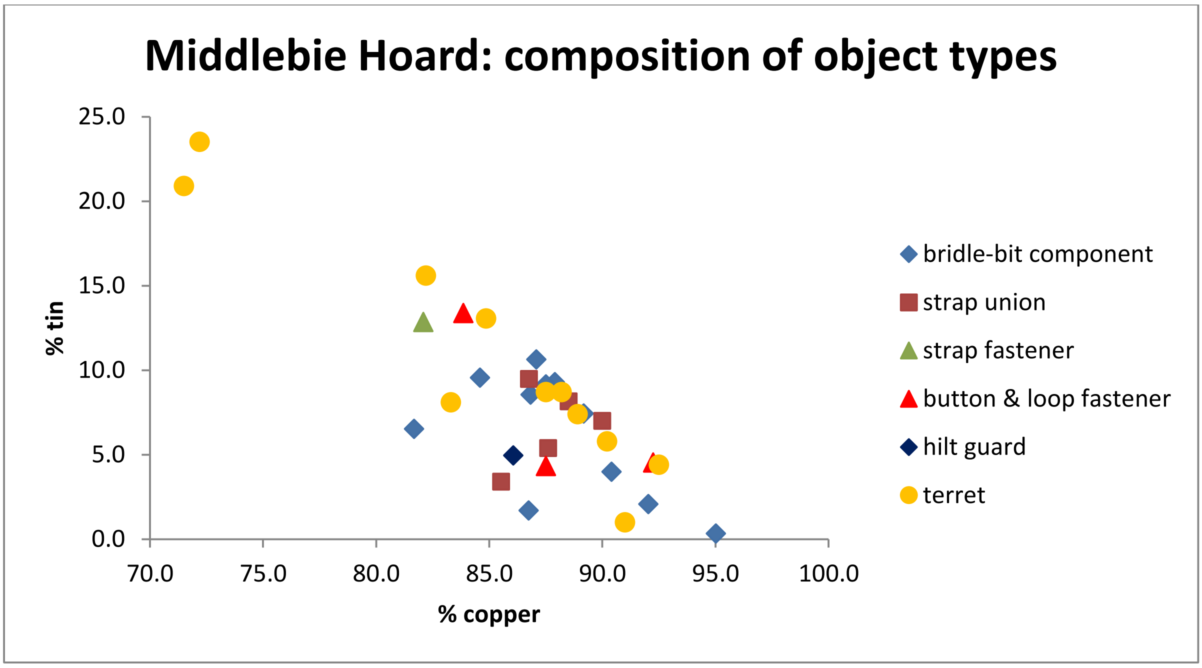


Figure 9. 4: Copper and tin content of object types in the Middlebie hoard, showing a variety of compositions for many artefact types, partly due to the addition of lead and/or zinc.

The scatter diagram above (figure 9.4), reflects the semi-quantitative nature of the analysis. Aside from significant quantities of major elements present, there were also often relatively low levels of lead, tin and zinc recorded in almost all of the objects, whether brass or bronze. True quantitative analysis of these metals would certainly give more information about the detailed use of alloys, and would help to ascertain how deliberate such use was in the context of the fluctuating, but increasing use of both brass and leaded bronze during the first century AD. From these analyses it appears that the quantities of zinc, tin and lead as minor alloying elements mostly seem too small to represent their deliberate addition within that melt, but could reflect re-use or recycling of metal. However, relatively small quantities of lead (Dungworth 1996, 402) can make casting easier to achieve, and the addition of a small quantity of tin when added to a brass 'improves the casting properties and wear resistance' of the metal (Northover 1999, 137). The use of less pure or recycled metal was therefore advantageous to some extent, but also demonstrates a different attitude by metal smiths manufacturing objects in this hoard, to the use and mix of alloys used in the equivalent hoards from Stanwick/Melsonby (Dungworth 1996, 419-20), Seven Sisters (Davis and Gwilt 2008; chapter 7) and Polden Hill (chapter 6). This is true for horse equipment in particular.

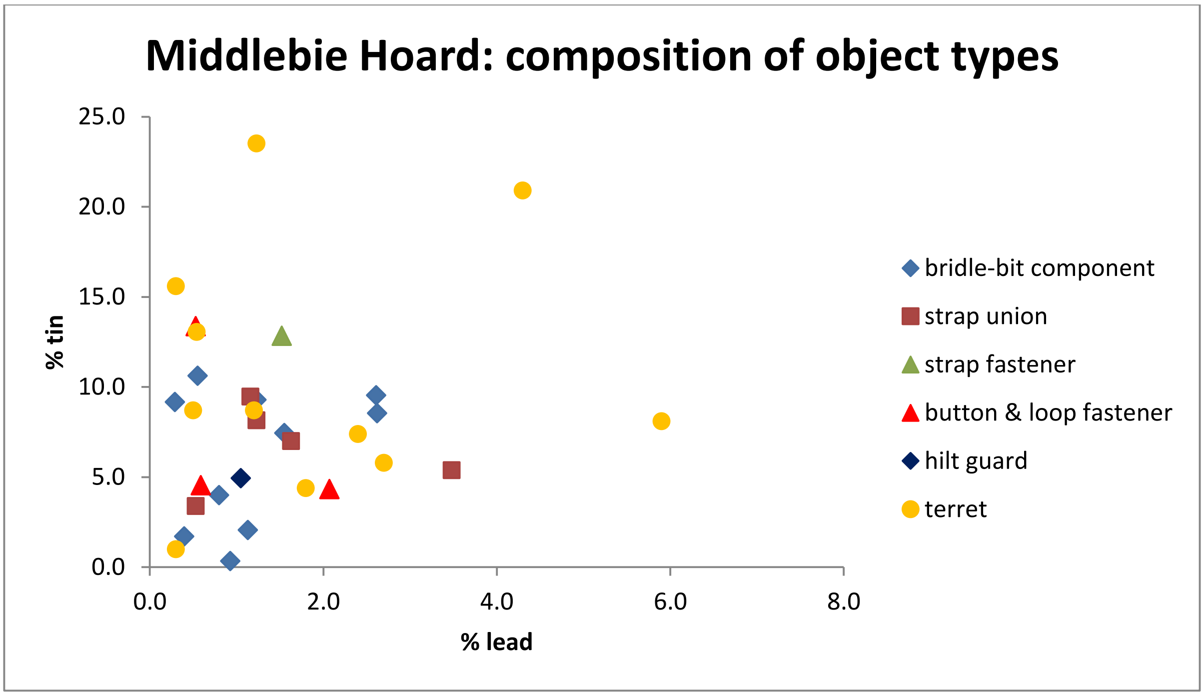


Figure 9. 5: Scatter diagram showing large variation in the quantities of tin and lead within the components of the hoard, whether bronze, brass or gunmetal. This is in contrast to other LIA hoards.

The presence of minor or trace elements when present in objects can help categorise or group the artefacts. For example, in figure 9.6, it can be seen that the elongated strap unions (FA 49-51; green triangles; figure 9.18-20) and the four bridle-bit rings (FA 45-48; blue circles; figure 9.30) are similar in composition to one anothere for minor (as well as major elements) so it is likely that these two groups of artefacts were each made from the same metal source.

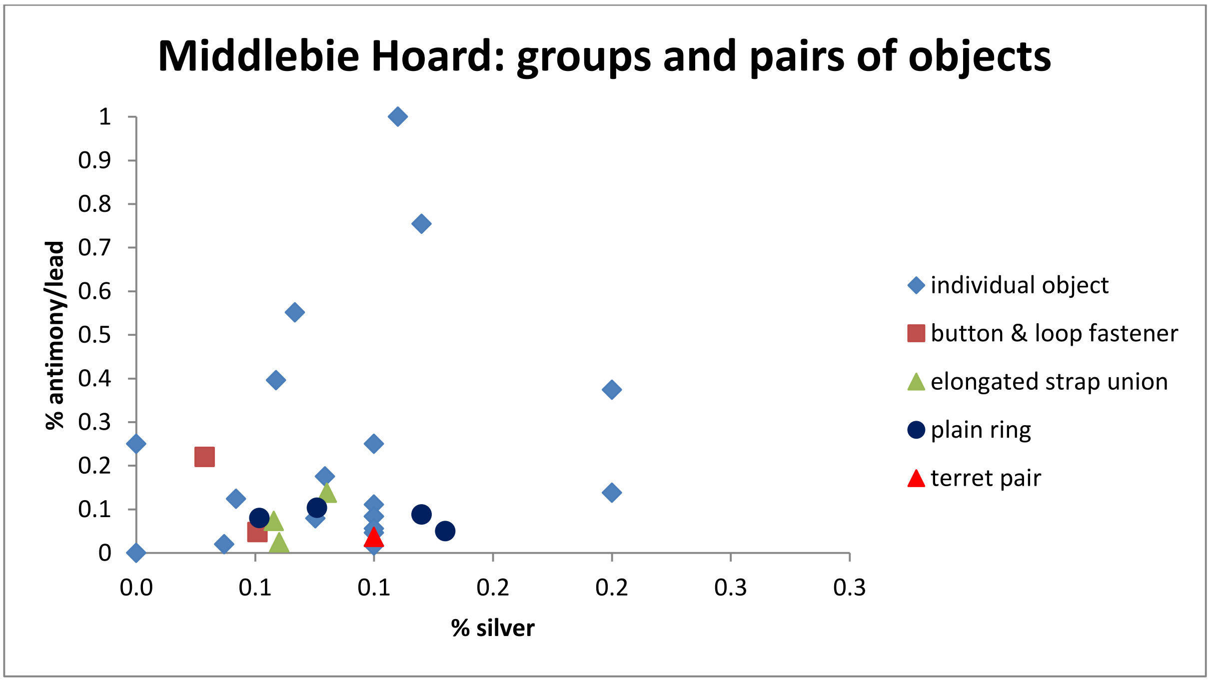


Figure 9. 6: Scatter diagram using trace elements showing individual and 'groups' of objects from the Middlebie hoard.

Types of Object

Terrets

Terrets are the most numerous category of find within the Middlebie hoard; there are eleven in all, and the majority appear to be single objects rather than pairs or sets, both in style and in metal composition. However, they are of largely similar types; all but one being either simple or knobbed terrets (figure 9.7), but with a variety of bar styles for fastening to the yoke (figure 9.8) (see appendix 9 for fastening techniques).

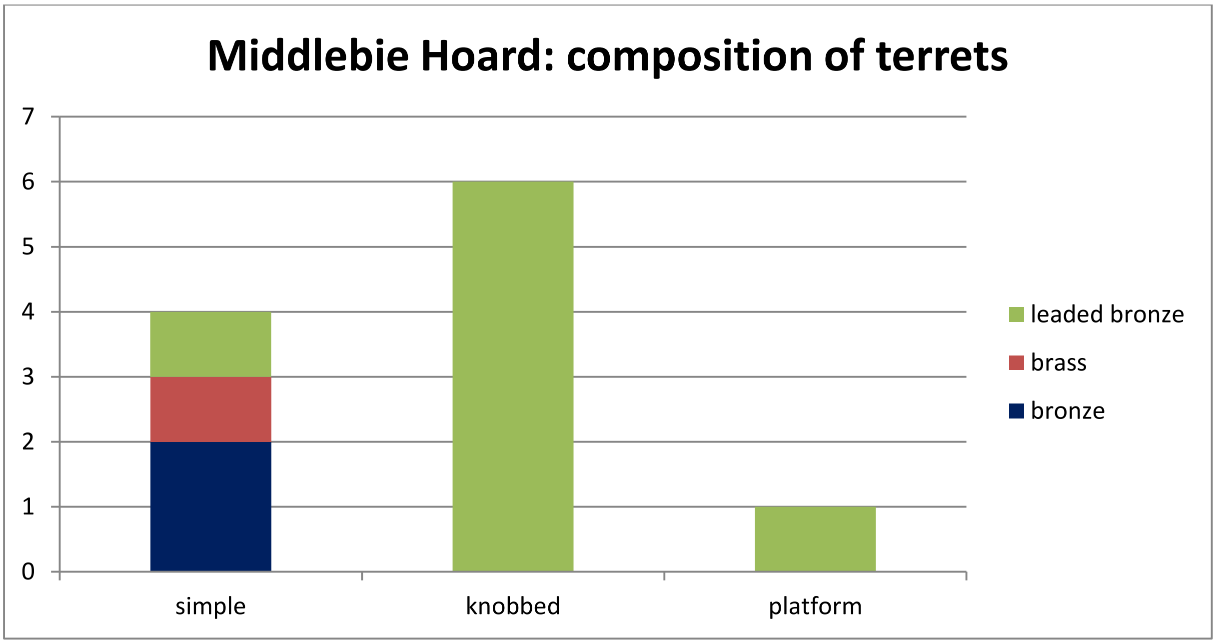


Figure 9. 7: Gunmetals are not present, but the majority of terrets contain over one percent lead. The simple terrets show consistent use of unleaded metals, whereas the platform terret and three knobbed terrets contain considerable quantities of lead.

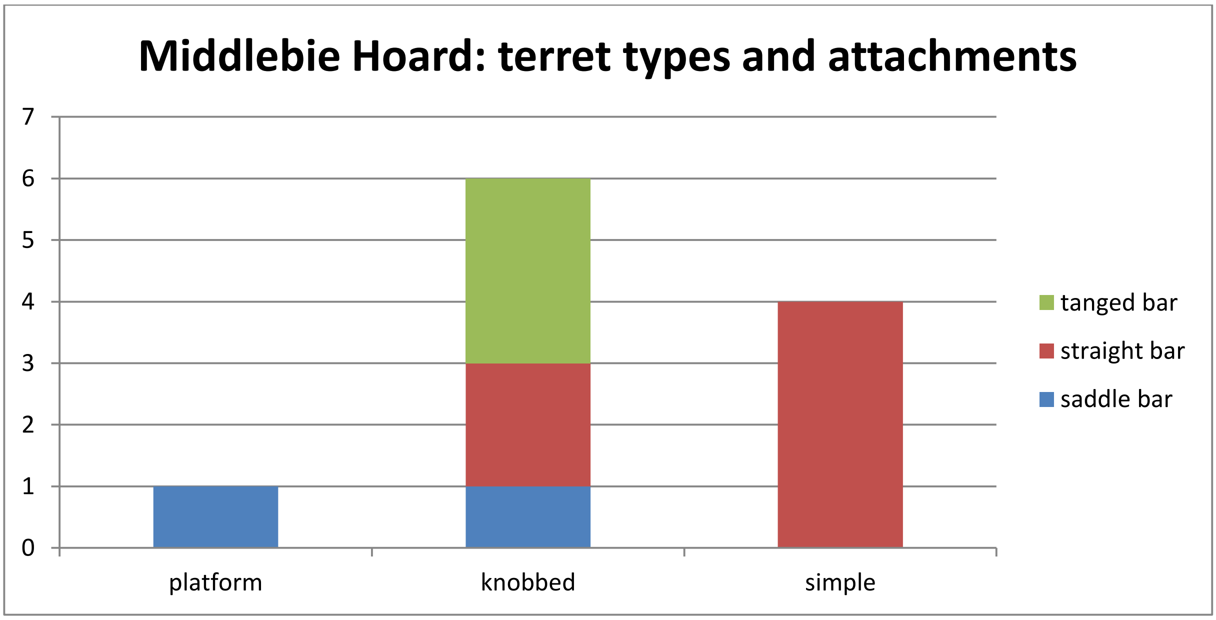


Figure 9. 8: graph showing the variety of bars on the terrets for attachment to the yoke; the simple terrets, although least consistent in metal composition appear most consistent in overall style - all having straight bars.

Platform terret

There is one terret within the hoard of a different 'type', FA 58 (figure 9.9), which although similar in many respects to knobbed examples, is described by MacGregor as a platform terret (MacGregor 1976, 2 72); comparable examples are found from Stanwick and Traprain (MacGregor 1976, 1 45). The Middlebie example has four platforms set with blue glass, and a saddle bar. As with several 'northern' styles of artefacts types (e.g. cruciform strap unions (MacGregor 1976, 1 35), MacGregor considers these to be a northerly adaption of Icenian origin and Brigantian manufacture (1975, 1 45-7), 'Knobbed and platform terrets seem to be a twin and interlacing development, whose popularity may have been stunted in their home area by the enforced peace with Rome, but whose adoption in the North was compensatingly enthusiastic'. The provenance, date and design of many of these terrets makes a northern British, rather than a south eastern English origin more likely, and their use might reflect similar ideas of status and statements of independence and resistance expressed in comparable objects from northern and western England and from Wales.

Figure 9. 9: Terret FA 58; it has a saddle bar attachment and four 'platforms' set with blue glass inlays.

The platforms have been cast with central circular cells for the glass, and have each been inlaid with a small fractured fragment of blue glass, the surface of which has not been polished down (figure 9.9; 9.37). This terret is relatively large, and together with its greater decorative detail, plus its saddle-bar attachment (as with the large knobbed terret FA 59 (figure 9.10; 9.12) and examples from the Polden Hill hoard) could make it a candidate for a central piece within a set.

Knobbed terrets

Figure 9. 10: knobbed terrets from the Middlebie Hoard: this type of terret tends to have three evenly spaced knobs on the ring.

The majority of the Middlebie terrets are 'knobbed' terrets, with three evenly spaced protrusions around the ring (figure 9.10). Macgregor (1975, 1 46) suggests there is 'a peak of production for this style in the first half of the second century, rather than the second half of the first', making them generally slightly later in form than lipped or platform terrets. However, within this hoard they are buried with terret types produced in the first century AD, which could suggest some of the Middlebie artefacts were older when buried.

The lead content of the different terret types, when plotted against the major alloying constituents of tin and zinc (figure 9.11), does seem to illustrate some compositional difference between the knobbed/platform terrets and the simple terrets. The exception to this is FA 64 (circled in figure 9.11), which has a brighter surface appearance (figure 9.10; middle left).

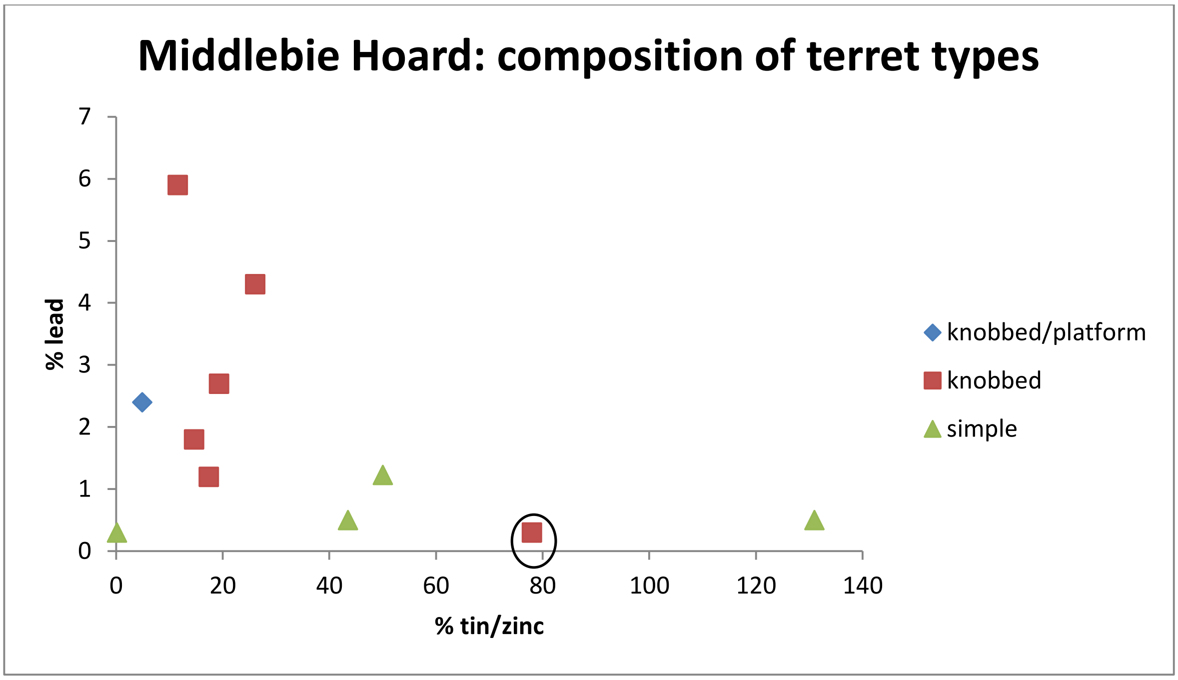


Figure 9. 11: Scatter diagram showing different terret types largely consistent in terms of low lead content on the horizontal axis (simple), and low tin/zinc content on the vertical axis (knobbed/platform).The knobbed terret FA 64 is circles.

A relatively low level of lead can be seen for all the simple terrets; whereas the knobbed and platform terrets contain a very similar ratio of tin/zinc to one another, but variable lead levels. As stated above, the one outstanding knobbed terret with low lead and a higher tin/zinc content is FA 64 (circled in figure 9.11); and one of the only 'pair' in the hoard with FA 63 (central terret in figure 9.10). The composition of FA 64 shows that it was made from a distinctly different metal from the other knobbed terrets, and may well have been manufactured at a different date. The shape, size and weight of the terret FA 64, as well as wear patterns, suggest this was made to complement terret (FA 63); possibly as a replacement for an original component of a 'pair' or set. The state of the metal surface for FA 63 and FA 64 are also very different, and as the burial conditions were the same, this potentially indicates a different age or life history before deposition.

MacGregor (1976, 2 90 and 91), feels that the two terrets (FA 63 and FA 64), were from different moulds; however, they look identical except for the pointed area of the tang on the bar (a difference which could be attributed to casting and finishing or fettling). This pair is interesting, as their shape and wear patterns imply that both were originally modelled on a similar but slightly worn example, or that one was modelled from the other. Their weight and dimensions are very slightly different, as is the case with many such similar 'sets' or pairs of objects (for example, the terret sets from Polden Hill (chapter 6). This might mean that a completed object was used to form a clay impression from which to form the template for the next example. The shrinkage of the clay of the investment mould when fired, and of the metal when cooled would result in an object of very similar appearance but slightly different dimensions; and with this method of manufacture, different melts would be used for the first object of a set or a pair. The terret pair FA 63 and FA 64 have significantly different elemental compositions in terms of the proportions of major elements, and the presence and absence of trace elements (figure 9.13 red triangles); FA 64 appears to have significantly more antimony, but less arsenic/silver. This could suggest not only a different casting episode, but also one which used a differently sourced metal, so potentially shows different levels of access or control over the source of the metals and the alloys used within sets of objects.

Figure 9. 12: Middlebie terrets FA 63 and FA 64 with a tanged bar (weight: 36g and 34g), and the similar but larger terret FA 59 with a saddlebar (weight: 97g).

Although the surfaces of the two terrets FA 63 and FA 64 have survived in very different conditions, their overall asymmetrical shapes are very alike (figure 9.12). It is possible that the present shapes of the objects are the result of one of them being cast as a matching asymmetrical pair for the other, rather than having developed the similarity in shape as a result of differential wear while in use.

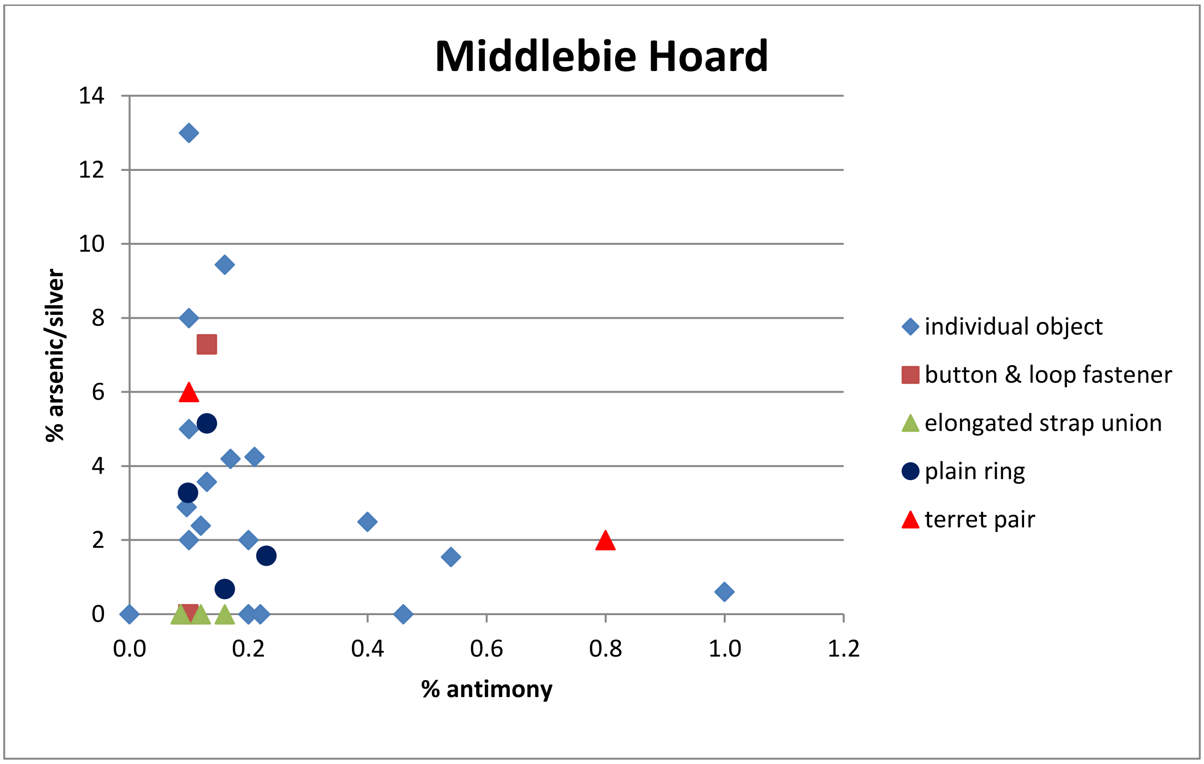


Figure 9. 13: The difference in both major and minor metal element composition in the terret pair FA63 and FA 64 suggests two different casting episodes and metal sources.

Many of the remaining knobbed terrets are of similar weights and sizes to one another, except for the large knobbed terret (FA 59). This is similar in appearance but different in size to the pair FA 63 and FA 64; it also has a saddle bar rather than a tanged bar (figure 9.12). It could originally have formed the function of the large central terret, attached to the centre of the yoke, within a set of four smaller examples.

Simple terrets

There are four simple terrets in the hoard; this type is both long-lived and has a broad geographical distribution. Two of these terrets FA 67 and FA 58 within the hoard are partial (figure 9.14), and both of these have a hollow interior. Although one of the simple terrets (FA 68), contains lead (figure 9.7; 9.11), the quantity is only just over one percent (1.2%), so could be regarded as borderline for the deliberate addition of this metal. This means three out of four of the simple terrets could be categorised as bronze with the fourth (FA 61) as brass. This clear division of brass and bronze (rather than gunmetals), and the use of unleaded alloys reflects the more usual nature of the composition of horse harness material in the other hoards e.g. Stanwick/Melsonby (Dungworth 1997), Polden Hill (chapter 6) ansd Seven Sisters (chapter 7).

Figure 9. 14: the partial and hollow simple bronze terrets; FA 67 and FA 68 (see appendix 9).

Figure 9. 15: Simple terrets FA 60 (brass) and FA 61 (bronze).

Strap Unions

There are five strap unions in the hoard; this type of object is defined as having two bars on the reverse for holding leather straps. These consist of three elongated, one cruciform enamelled and one plain bossed strap union.

Enamelled cruciform strap union

The most elaborate of the strap unions is the cruciform (or petal) enamelled example; in general these have a predominantly northern provenance (Macgregor 1976, 1 34). Macgregor (1976, 1 35) believes they were a development from the strap unions with 'concealed bars' (for example those from Seven Sisters (chapter 7), and so were created to take attached hidden strap bars on the reverse.

The composition of the metal (gunmetal, but predominantly containing copper and zinc with small amounts of tin (c.3.4%)), as well as the geometric form of the design, makes it seem very likely that this strap union was originally filled with polychrome enamel rather than red glass, which is implied by the present red waxy restoration. MacGregor also makes this point, but in relation to the similarity in style of this piece to that from Soham Toney (MacGregor 1976, I 34). Although this strap union is a gun metal, the amount of tin present would have enhanced the golden colour of the alloy (which is 9.5% zinc to 3.4% tin). Fang and Mc Donnell 's work on the colour of different copper alloys shows that '4% tin gunmetals [with] the addition of between 6% and 10% zinc produces a gold-like hue' (Fang and McDonnell 2011, 57), which is similar in colour characteristics to a brass with 15% zinc (Fang and McDonnell 2011, 56 fig 3). This is the colour which would have been obtained on many of the equivalent brass objects, for example with the brass harness pieces from Stanwick/Melsonby (Dungworth 1996; 1967), Seven Sisters (Davis & Gwilt 2008), and Folly Lane (Northover 1999). It poses the question as to whether this object drew on the highly sophisticated deliberate manufacture and use of this alloy; (the addition of tin to a brass 'improves the casting properties and wear resistance' of the metal (Northover 1999 137)); or it was the improvisation of an experimental or accidental alloying episode which was used advantageously. The colour of the alloy would convey the impression of a particular type of object with a specific composition; the golden colour, compared to bronze may also have conveyed specific visual signals in terms of cultural affiliations, contacts and alliances. This particular copper/zinc/tin alloy does not seem to occur regularly in native first century AD metalwork, although there are a couple of examples of a similar composition in the Stanwick/Melsonby Group B harness set (MacGregor 1976, 2 no.30: *button and loop fastener*, and possibly no.14: *looped mount*; Dungworth 1996, 420). Metallurgical analysis of a greater number of early second century artefacts might help answer how deliberate its use was.

Figure 9. 16: Enamelled cruciform terret FA 55, showing a miscast area and the relatively crude finishing on the reverse. The red inlay is modern restoration; it was probably originally polychrome enamel.

There are two major features of this strap union (FA 55), and of the bossed cruciform strap union FA 56 (figure 9.17), described below which are worth some further discussion. One is that they are miscast, and the other, as with all the strap unions from this hoard (and in common with objects such as the horse brooches from Polden Hill (chapter 6), is that they have been carefully formed and cast on the obverse side, but have a relatively crudely cast solid back onto which the strap bars are attached.

Bossed cruciform strap union

Figure 9. 17: Bossed cruciform strap union FA 56: obverse and reverse.

Although far less embellished than the cruciform strap union FA 55, this second strap union from the hoard also exhibits northern characteristics in its ‘boss style’. MacGregor (1976, 1 184) refers to this as from ‘a lowland Scots ‘School’’ and writes that ‘for the ‘Boss Style’; an ancestry in the south may be suspected, but only in north England and lowland Scotland does its use verge on mania’ (MacGregor 1976, 1 29).

The alloy for this object is essentially bronze, as the additional lead is at c. 1.2%, and again this could be a minimal deliberate addition, an accidental inclusion or due to the inaccuracy of the analysis. The strap union contains about eight percent tin, which would favour a composition for wrought rather than cast bronze (Dungworth 1995, 5.2.3); however, the addition of small quantities of lead would favour cast technology, and could point to its deliberate use in the cast copper alloys in this hoard.

Elongated strap unions

Three of the strap unions comprise a set of ‘elongated’ strap unions FA 49-51 (figure 9.18); as with strap fasteners (figure 9.25), these objects could potentially be used for clothing or belts, but are usually associated with horse trappings (Macgregor 1976, I 32). These types of strap union ‘are united solely by length and by paired strap bars on the underside...The four Scots examples are faintly bowed in profile, suggesting a possible use in face harness’ (MacGregor 1976, I 35). There are a further two examples from northern England, and one from Leicester (MacGregor 1976, I 58). Macgregor also points out that the Middlebie examples have ‘baluster mouldings which recall a small series of dumbbell buttons, of lowland Scots and north English distribution’ (Macgregor 1976, 1 35); so this group, like much of the hoard shows a common geographical attribution both in object type and style.

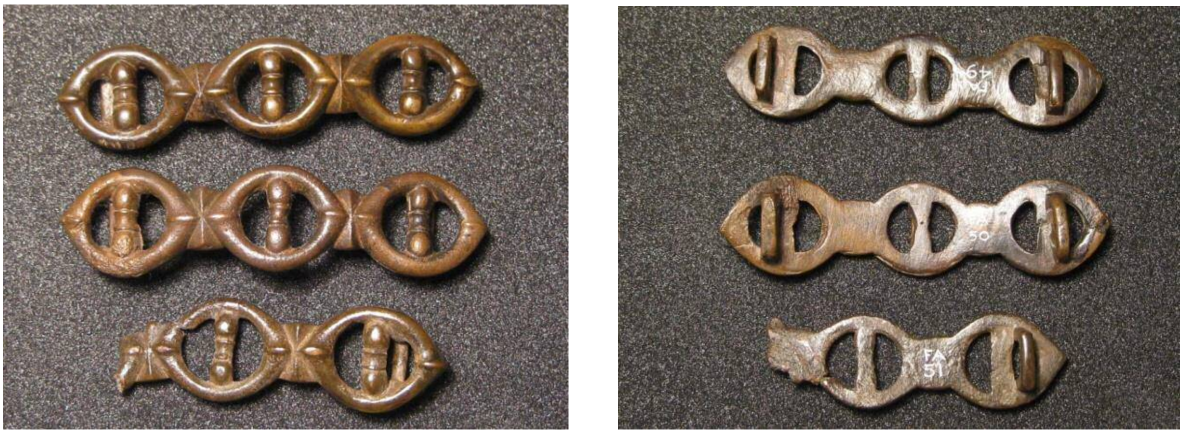


Figure 9. 18: Obverse and reverse of Middlebie elongated strap unions (FA 49-51).

The composition of the elongated strap unions show that they are virtually identical in terms of the presence, absence and quantities of trace elements (nickel, zinc, arsenic, silver and antimony; (figure 9.6), but are slightly varied in their major elemental composition (figure 9.34); the copper versus tin scatter diagram shows the objects are of similar composition but not very tightly grouped. An assumption from this is that the same source of alloyed metal was used, but the objects were possibly made during different casting episodes.

As has been argued in relation to the two similar knobbed terrets in the hoard, it is possible that near identical objects could be made by using an initial item as a template, and further castings could be manufactured from that. Here, the plain unworked back of the elongated strap unions suggests an impression was made of the front only; and a relatively less carefully worked back of the mould, incorporating voids for the strap bars, was used on the reverse. Further evidence for this is drawn from the fact that although the objects are nearly identical on the obverse, the strap bars have all been positioned slightly differently on the reverse (figures 9.18; 9.20). A further surmise is that originally a pair was needed, but miscasting led to the production of a third example. Both FA 50 and FA 51 are miscast, but FA 50, as with the cruciform (FA 55) and boss strap unions (FA 56), could be used despite the flaw, and may well have been repaired on its underside (figure 9.19). Other objects in the hoard exhibit signs of use and repair, but FA 51 is the only ‘partial’ piece. The thinness of the middle portion of this object indicates there may well have been poor metal flow during production, which resulted in the damaged and incomplete cast (figure 9.18; 9.20).

Figure 9. 19: Casting flaw on one end of FA 50, possibly repaired on the reverse face

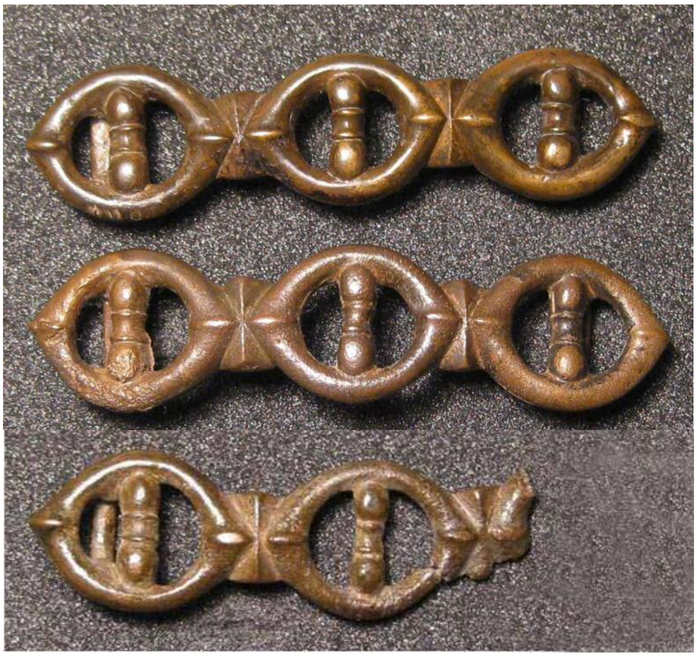


Figure 9. 20: FA 49-51; differences in shape and size could be attributable to less well cast ‘copies’ of FA 49 (top). It can be seen that the strap bars are placed in slightly different locations on the reverse of each object.

Button and loop fasteners

Although some button and loop fasteners could have been intended for use on clothing (Macgregor 1976, 1 130); the context in which the Middlebie examples were found implies they were for harness equipment of some kind (Macgregor 1962, 23; Wild 1970, 145) (appendix 9).

Boss/petal-headed button and loop fasteners

Button and loop fasteners seem particularly prevalent on northern British sites, (Wild 1970, 146; Macgregor 1976, 1 130); and the pair from Middlebie FA 53 and FA 54, showing the northern ‘boss style’ or ‘petal-head’ (figure 9.22) fit this pattern well. They are also compositionally interesting; although they are undoubtedly a pair; their major alloying elements vary, with FA 54 containing comparatively significant additional quantities of both zinc and lead (figure 9.21); and the amount of minor elements also show differences (figure 9.6; 9.13); FA 53 is a low tin bronze and FA 54 is gunmetal. The use of different alloys means the two objects were made during different casting episodes.

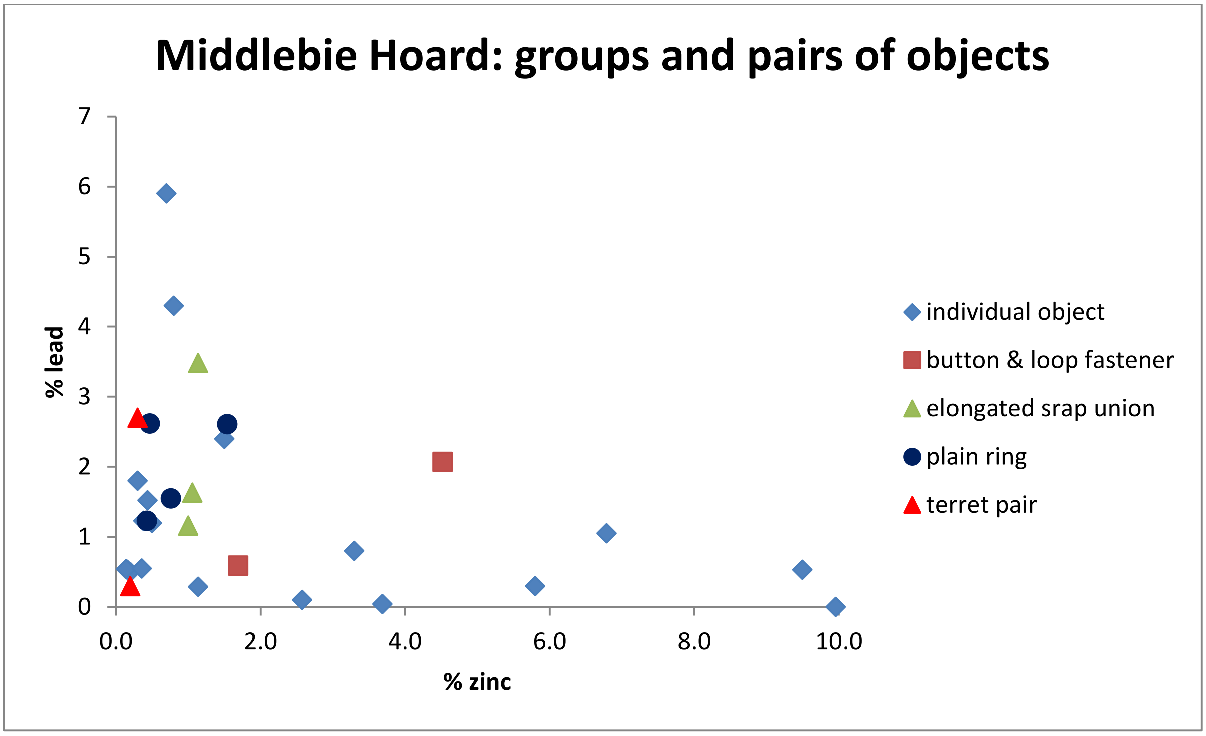


Figure 9. 21: scatter diagram showing levels of zinc and lead in groups and pairs of objects

The casts themselves are more carefully made in some respects than the strap unions; here the backs of the bosses are not solid, but carefully cast to reflect the contours of the obverse side; this would require more skill to achieve, but use considerably less metal in the process.

Figure 9. 22: Obverse and reverse of Middlebie FA 53 and FA 54. A pair of near identical button and loop fasteners, with different elemental compositions; FA 53 is a low tin bronze, whereas FA 54 is a gunmetal.

Ring-headed button and loop fastener

The third button and loop fastener FA 52 (9.23; 9.24) in the hoard is very different in style, and is of the rare 'ring-headed' type (Macgregor 1976, 1 131); this particular piece is described as 'an unusually complicated example of this class (Wild 1970, 138). This fastener has several decorative elements including an excised triangle for taking glass or enamel decoration (now restored with a red waxy inlay). The recess appears to have been cut out of the metal, and is very different from the deliberately 'cast in' examples made for the glass inlay in the platform terret FA 58 (figure 9.9) and for the strap union FA 55 (figures 9.16).

There are two possibilities as to what the original inlay was made of: a polychrome enamel inlay similar to that which would have originally been in the cruciform strap union, and as seen on the majority of the horse harness equipment from the Seven Sisters hoard (chapter 7), or red glass. There appears to be very little red glass on artefacts from this area, unlike from the more southern hoards, or north eastern assemblages such as Culduthel or Birnie (Davis and Freestone forthcoming), but it is possible that this triangle was later cut to take such a piece (as with some of the excised cells in terrets from the Polden Hill hoard (chapter 6). If so, the glass could have been the La Tène sealing wax red type, used on the vast majority of first century AD harness pieces made from tin bronze metal and decorated in this way. A further possibility is the use of a substituted Roman type red glass, which has intermittent appearances in similar LIA material (for example the Polden Hill horse brooch (chapter 4; chapter 6).

Figure 9. 23: Button & loop fastener FA 52; bronze composition more allied to simple terrets; tin bronze.

Figure 9. 24: Detail of infilled area of the button and loop fastener FA 52 and the strap union FA 55; both are now filled with a modern red waxy material, but the triangle on FA 52 appears to have been cut from the metal post-casting, whereas the decoration on the strap union was 'cast in'.

Strap fastener (Looped stud)

Strap fasteners are like a cross between button and loop fasteners and strap unions; they are often similar in size, form and distribution to the former, but have a single strap bar on the reverse (Macgregor 1976, 1 134). The Middlebie example FA 69 has a bossed petal decoration similar to the pair of button and loop fasteners from the site, but has a solid cast back, more reminiscent of the strap unions (figure 9.25).

Figure 9. 25: Looped stud FA 69; boss style with cast flat back and attached strap bar

The strap fastener could also have been used for clothing or horse harness; but the latter seems more probable in the context of this hoard. The alloy used for the object is a tin bronze with c. 13% tin, but also with approximately 1.5% lead which would have aided the flow of the metal when casting the object.

Bridle-bits

One area in which elemental analysis stood out was in the variable composition of the multiple parts of both bridle-bits. Quantitative analysis on the metal components from the bridle bits in the Polden Hill hoard (chapter 6), showed some variation through trace elemental analysis, and the 'geometric' style brass objects from the Seven Sisters hoard (chapter 7) showed that one of the bridle-bit rings was of a slightly different composition to the other analysed objects (Chapter 7). This confirms manufacturing processes; some sections needed to be cast on to others when making complex multi-component objects; but there are also further possible reasons for the use of different metals for components with variable compositions on the same object.

Three-link Derivative bridle-bit

For the bridle-bit FA 71 from the Middlebie Hoard, it appears that the colour of the visible components must have been of significance. The metal composition of three link derivative bridle-bits tend to show significant variation within their individual components, and in many respects the Middlebie example (figure 9.26) compares well to other bridle-bits, such as that from Folly Lane (Northover 1999, 137). The elaborate ring on the Middlebie example, i.e. the outer visible component of the bridle-bit when worn, is of brass, whereas the link is gunmetal. Although the less elaborate ring is also brass, it is predominantly copper with a very low quantity of zinc (c. 2.6%); (appendix 9). For the Stanwick/Melsonby hoard, where both the rings and the links have been analysed, a similar pattern occurs (Dungworth 1996 419-421). Although colour seems significant, other factors could also be important; this use of a mixture of copper alloys could also indicate relative availability of alloying materials, greater ease in casting on different alloyed components, the use of 'harder' metal for the mouth section, and possibly the taste of certain metals in the horse's or pony's mouth was more acceptable to the animal (Moi Watson pers. comm.). A further possibility is the cannibalisation of parts, or the use of a 'stock' piece from components unused by the bronze smith during previous episodes of casting and manufacture; it could be argued that the four very similar and successfully cast bridle-bit rings illustrate such practices.

However, the strongest argument does seem to be for the golden appearance of brass for the most elaborate section of the bit, which would be on the outside, and therefore the visible side of the pony when pulling a cart or chariot.

Another feature of this Middlebie bridle-bit is the evidence for extensive use. The ring sections are very heavily worn at both extremes. As Palk has pointed out, this is likely to be a result of the design of three-link derivative pieces, where the rings cannot swivel, so there is perpetual wear on the same area (Palk 1984, 90) (appendix 9). Although this bit is very two-dimensional and has a flat back; the bosses, as with the button and loop fasteners of similar style, have been cast hollow. The form of the link when seen from the reverse looks as though the metal has been folded or rolled into a seam, and therefore could be hollow (figure 9.27).

Figure 9. 26: Bridle-bit FA 71 showing heavy signs of wear and asymmetric side-links/rings.

Figure 9. 27: Reverse of bridle-bit FA71, showing a flat cast back but with hollow bossed areas.

Single bar bridle-bit

The other bridle-bit from Middlebie FA 70, is described by MacGregor as unique amongst single bar bits (Macgregor 1976, 2 11; figure 9.28). The more bent ring and the link are bronze; the other ring is gunmetal, but with relatively small amounts of both tin (3.3%) and zinc (2.5%) compared to the other Middlebie pieces (although as always the metal composition from surface analysis needs to be treated with due caution).

The bridle-bit FA 70, in common with other objects in the hoard, exhibits signs of potential miscasting and repair; the centre-link has been repaired using a relatively heavily leaded bronze (over 10% lead) compared to all other alloys from the hoard.

Figure 9. 28: Single link Bridle-bit FA 70

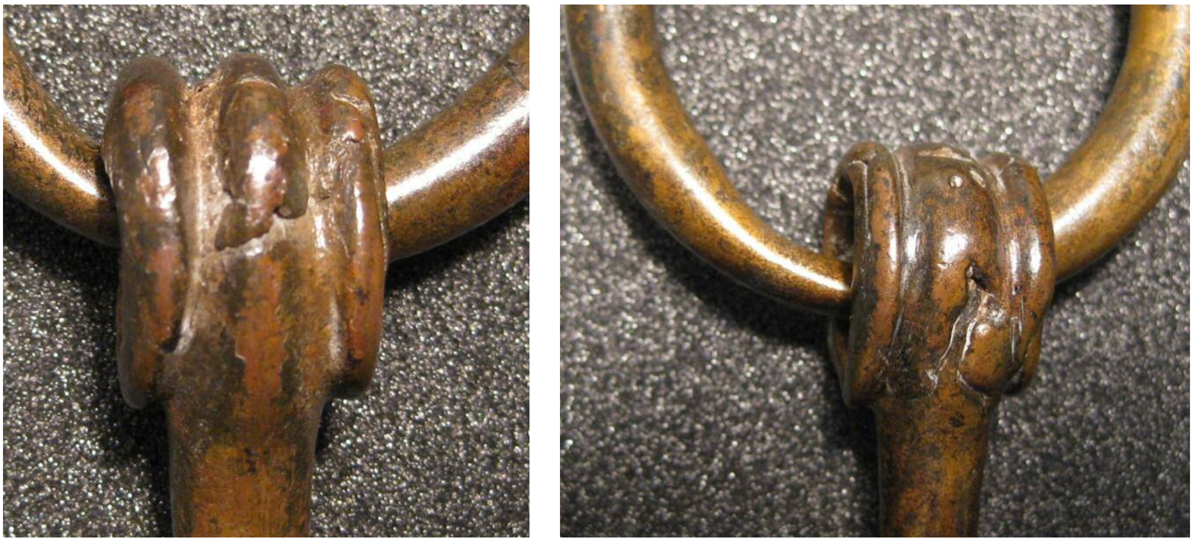


Figure 9. 29: leaded bronze repair on the end of the central ink of bridle-bit FA 70. Both ends of the bas look miscast.

Figure 9. 30: Obverse and reverse of the four single bridlebit rings from the Middlebie Hoard (FA 45-49).

Bridle-bit rings

The rings are very similar in size and appearance to those on the complete bridle-bit FA 70, and of a similar circumference to the ring/link of FA 71. The weights and dimensions of each ring vary slightly and a degree of wear can be seen on the opposing sides of the rings, especially FA 47 (figure 9.30, bottom left).

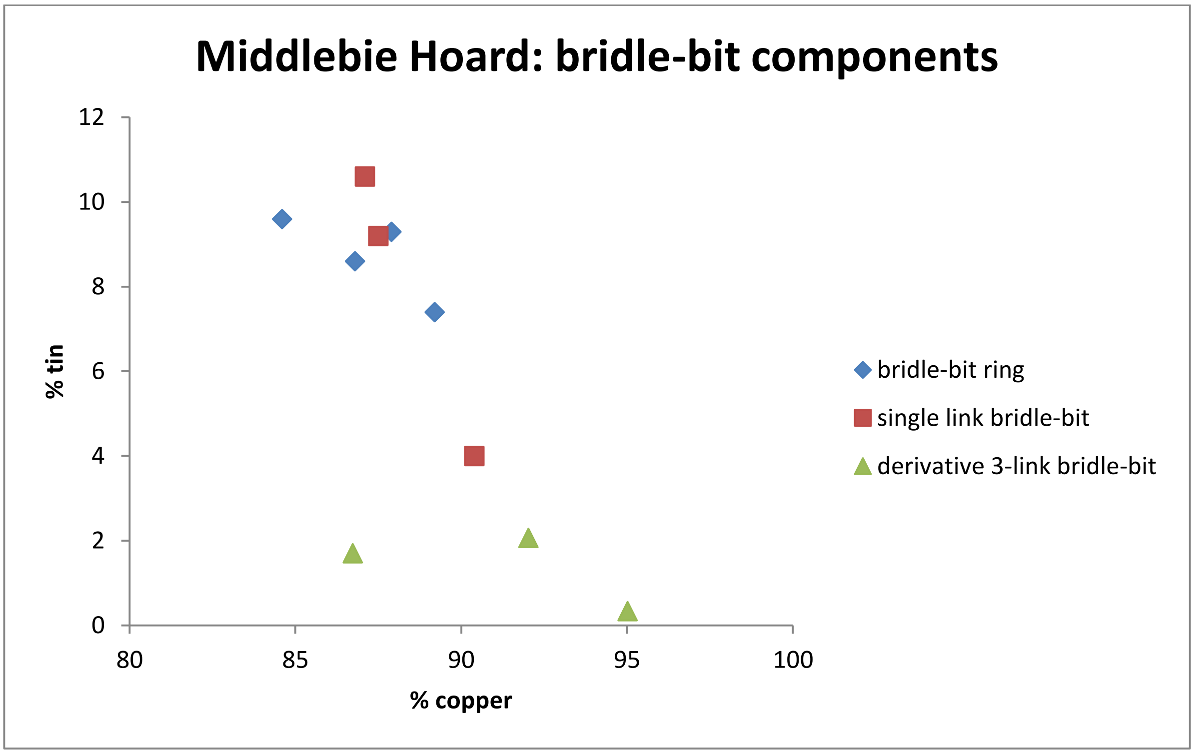


Figure 9. 31: scatter diagram showing the major element composition of the bridle-bit rings (FA 45-48) and individual components of the two complete bride-bits (FA 70 and FA71).

The scatter diagram above indicates a significant difference between the pieces making up the three-link derivative bridle-bit FA 70 (green triangles) and components from the single-bar bridle-bit FA 71; two of the latter pieces have compositions similar to the single rings FA 45-49, which are relatively alike. This potentially adds to the argument for a ‘stock’ of cast rings.

Hilt Guard

Figure 9. 32: Front and reverse of hilt guard FA 57 made from gunmetal.

The type of sword hilt guard from Middlebie FA 57 (Piggott IVB crown), is predominantly found north of the Pennines and in lowland Scotland (MacGregor 1976, 1 80) on 'Brigantian' type swords.

Analysis shows the metal is gunmetal with c.5% tin, 6.8% zinc and just over 1% lead. Dungworth (1996, 419-421) has analysed two Class IV sword hilts, a 'cocked hat' type from Sadberge in Co. Durham (MacGregor 1976, 2 156), and a 'round-shouldered' type from Worton in Lancashire; both these examples are brass with over 17% zinc, as are the chape and suspension loop (Dungworth 1996, 421) of a Brigantian scabbard from the Stanwick/Melsonby hoard (MacGregor 1962 29) (the hilt guard is missing from this item). Many class IV swords do contain substantial zinc (Dungworth 1996, 409 figure 9.18), which supports Piggott's original view that they date predominantly from the period of the Roman conquest, and possibly into the second century AD (Piggott 1950). This item, as with much of the Middlebie hoard shows a less regimented use of tin, zinc and lead within the alloy. It is possible that the metal used for this hilt guard represents either a later use of metal type, or a more northern use (or both), possibly as a result of the more restricted access to purer high zinc brass at this particular period and location.

Method of Manufacture and Composition

Some of the objects from the Middlebie Hoard seem to be similar in style and composition (though not identical). As stated above, the three near-identical elongated strap unions appear to be made from a similar metallic composition (figures 9.6, 9.12 and 9.32). At the same time it can clearly be seen they are subtly different in both appearance and weight and dimensions.

The relatively rough, flat backs of the objects suggest they were cast into a mould where only the front was moulded with care. This is unlike many lost wax castings where careful and precise three-dimensional moulding was achieved. A plausible explanation for such pieces is that they were made by impressing a pattern, or the obverse of an original object into clay, but as the reverse would never be viewed, much less care was taken over the appearance of the back. The mould would have to be covered at the back to form a satisfactory cast object (as with items such as Early Bronze Age flat axes (Dave Chapman; Dana Goodburn-Brown pers. comm.), but a relatively crudely made back incorporating the strap bars could be made for the reverse of the mould, making the process quicker and easier. This would also explain why the strap-fittings on the reverse of each of the three elongated strap unions are not positioned in the same place on each object. Their slightly convex shape could be achieved by annealing and bending after casting (MacGregor 1976, 33). A further refinement of this type of mould is visible on some of the 'boss' style objects; although the backs of these objects are largely flat, the deep bossed areas are hollow on both the three-link derivative bridle-bit (FA 71) and on the pair of button and loop fasteners (FA 53 and FA 54). There are practical reasons for casting in this way in that it saves metal, and makes a lighter object with a more uniform thickness, but would probably also require more skill and time.

A mould for making multiple near identical objects could be done by applying the original cast metal item directly into prepared clay to form accurate impressions of both the obverse side and where necessary the reverse side. Wax models could easily be created from these and would allow the subsequent objects to be manufactured more quickly, as a pattern or original object could be impressed several times for simultaneous manufacture, using *cire perdue* casting. This would mean that the metal of the original object and the subsequent castings could be different, as seen with the terret 'pair' FA 63 and FA 64, and the button and loop fasteners (FA 53 and FA 54). Button and Loop fasteners pairs from the Stanwick/Melsonby horse sets within that hoard also show different compositions for each one of a pair (Dungworth 1996, 420).

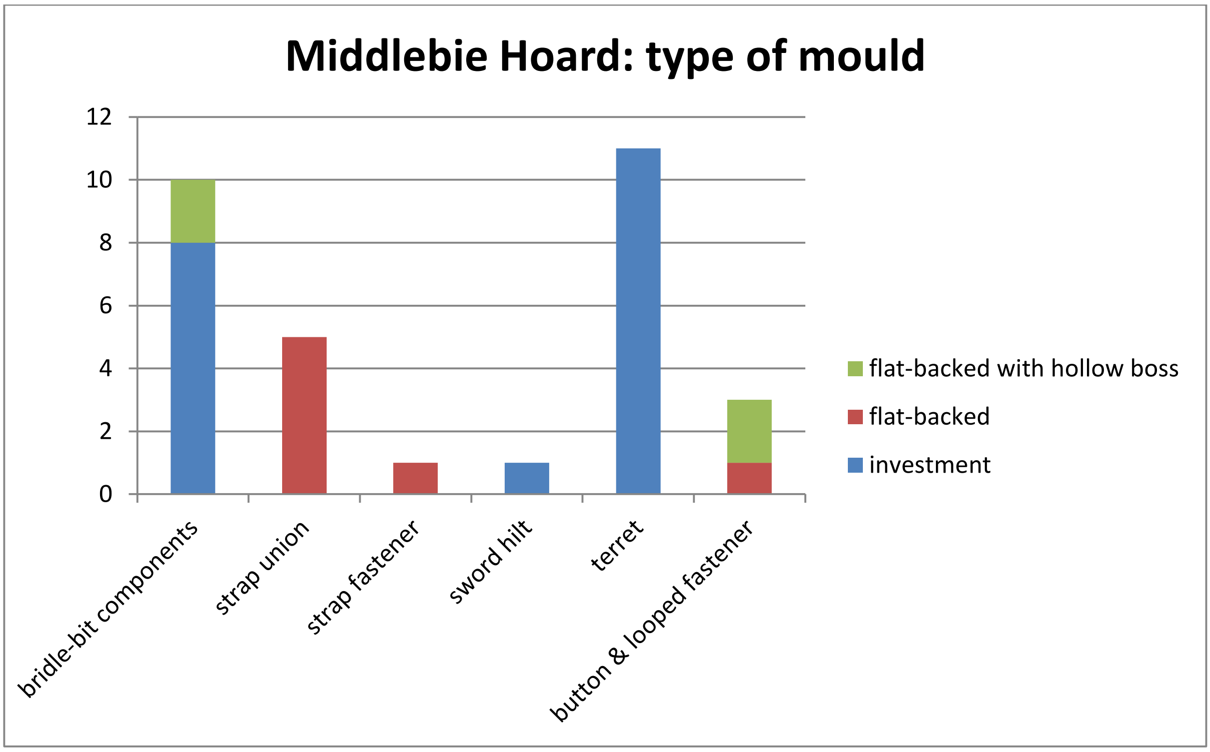


Figure 9. 33: Distribution of objects cast with a flat backed mould in the Middlebie hoard.

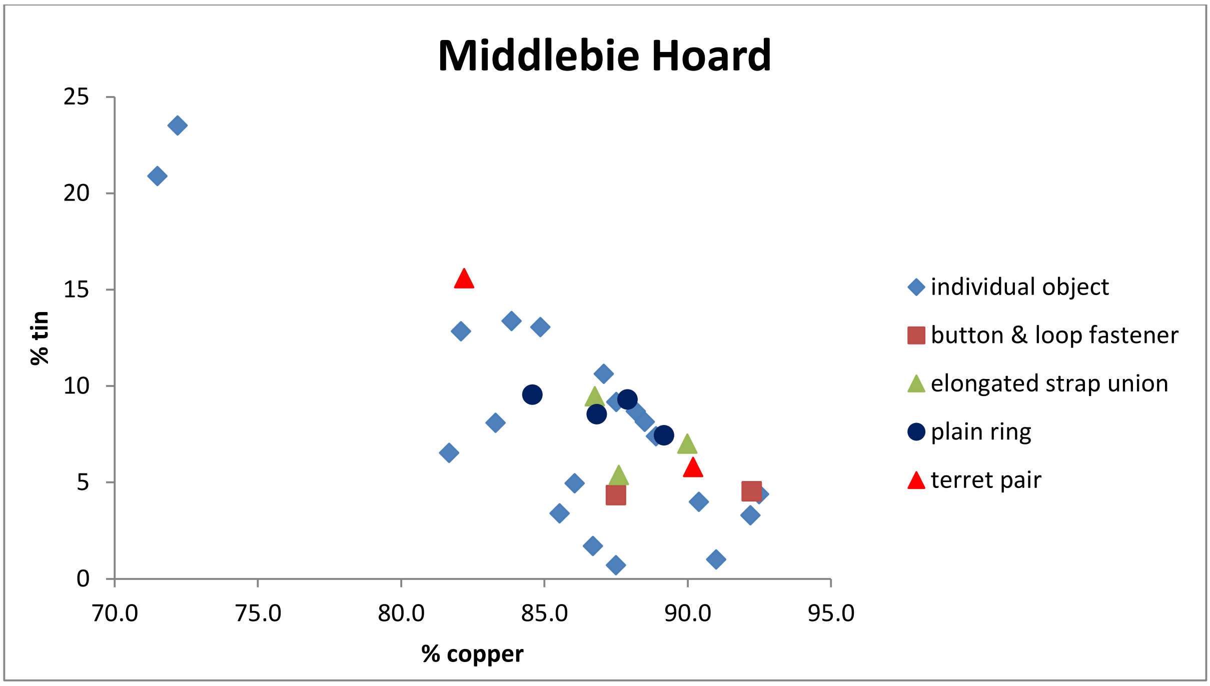


Figure 9. 34: Major alloying composition of pairs and sets of objects within the hoard (copper and tin). The terret and the button and loop fastener pairs show distinct differences in their major alloy compositions.

The use of wooden patterns has been advocated by authors such as Foster (1995) and Spratling (1972, 525). It seems practicable and likely these were used for relatively uniform parts of objects and identical objects, for example the fasteners on button and loop fasteners and the rings for bridle-bits (both present in Middlebie); but there does seem to be a unique and distinct nature to much of the horse harness equipment, and replication by temporary patterns (i.e. an original item) makes more sense for many of these objects; (a similar pattern in weight variability for near identical objects or sets of objects can also be seen within the Polden Hill material (appendix 4).

Another 'group 'of similar objects are the four bridle-bit rings. Their composition, dimensions, and simple style implies that several such 'standardised' rings could be made in one go, and a supply drawn on by the metalworker for the use of plain rings (as used with the bridle-bit FA 70), as and when required. In this sense, these components could be used with a degree of versatility for different sessions of casting, almost like standard or stock parts. MacGregor (1976, 1 12-13) notes a degree of wear on two opposed sides of each of these rings, which makes their inclusion in the hoard add another aspect of historical depth to their use and deposition (figure 28). Why they end up with the other material from Middlebie is then a further interesting point for discussion: it could be hypothesised that this was a founder's hoard; or the users and purveyors of chariot equipment collected spare parts. It could be that 'ownership' of the metal artefacts was as important as their function or use, or that there were agreements with particular metal smiths that items could be mended or cannibalised without the need to go back to the original manufacturer. Equally they could be a contribution to the hoard from the metal smith himself, possibly in a manner similar to the inclusion of tools, weights and scrap metal etc. seen in other hoards. If the horses were communally owned (as argued in chapter 10); the 'community' was likely to be the owner or guardian of the horse trappings in the same way as they were the horses themselves; if so, it might would not be an individual's decision to dispose of parts of this equipment but a collective and symbolic decision to do so.

Style of hoard

Decorative characteristics

One of the notable characteristics of the Middlebie hoard is that the general style of decoration is consistent across many of the pieces despite the variable composition of many of the artefacts. This is particularly pronounced with the use of the northern 'boss' style (Leeds 1933, 111; 116) where the artefact decoration 'is filled with a large, perfectly plain boss' (Leeds 1933 117). Leeds also notes terret rings 'decorated with plain round knobs occurs with some frequency', and that this 'may be regarded as characteristic of that region, where it is in full consonance with the 'boss' style' (Leeds 1933 122); as with the terrets from the Middlebie hoard.

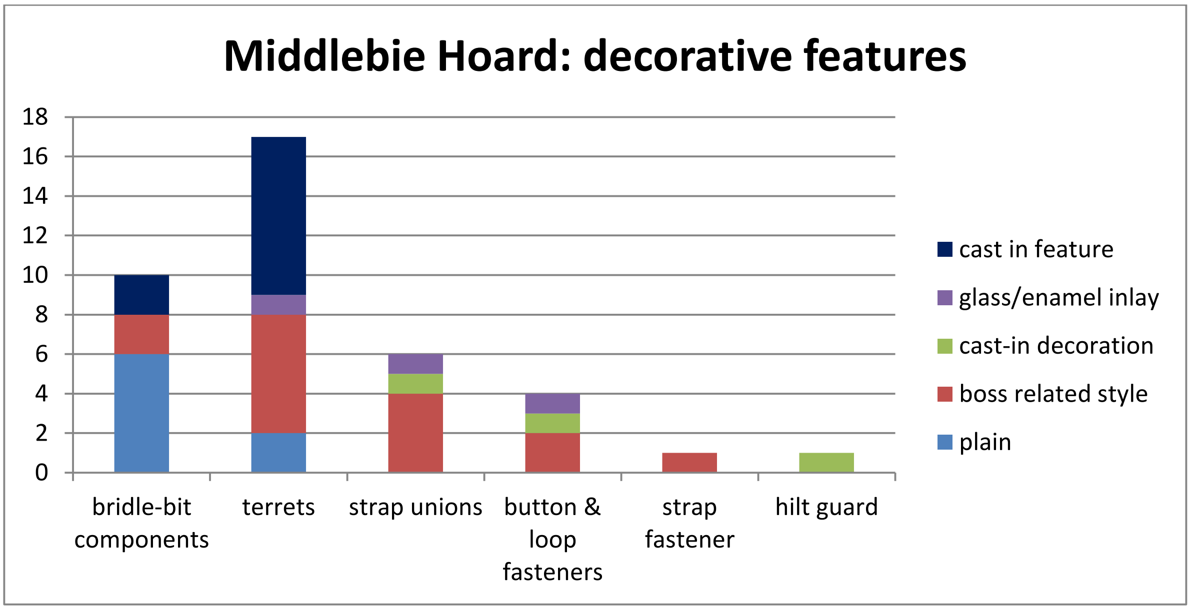


Figure 9. 35: graph showing the distribution of decorative aspects on objects from the Middlebie hoard (some objects have features in more than one category).

The boss style referred to in figure 9.35 includes related traits such as those on the elongated strap unions (FA 49-51) and on 'knobbed' terrets; these features are deemed northern and related in context and style. Cast in features include elaboration on objects such as the cast demarcation of the terret ring with the bar or the decoration on the hilt guard.

Aspects of style within this hoard are proportionately different to those in the other hoards examined for this study. Cast in decoration (other than bosses and knobs) is rare, as is the use of glass or enamel. Where glass or enamel has been used, different methods are visible in all three decorated objects: the strap union (FA 55) has cast in cells (figures 9.15 and 9.22); the button and loop fastener (FA 52) has an excised cell (figures 9.21 and 9.22); and the platform terret (FA 58) incorporates fragments of blue glass set into small cast recesses on its protrusions (figures 9.8 and 9.36).

Where there are cast in features, the majority of these are related to the elaboration of a practical or functional aspect of an object, such as the centre of a mouthpiece, or the 'ribbed' demarcation of the terret ring and the bar for fastening to the yoke (figure 9.16). There are no instances of 'scribed' decoration, either as ornamentation in its own right or to highlight cast in features such as inlaid cells; a style seen on many objects such as the pendant hooks from Seven Sisters (chapter 7) or much of the inlaid horse equipment from the Polden Hill hoard (chapter 6).

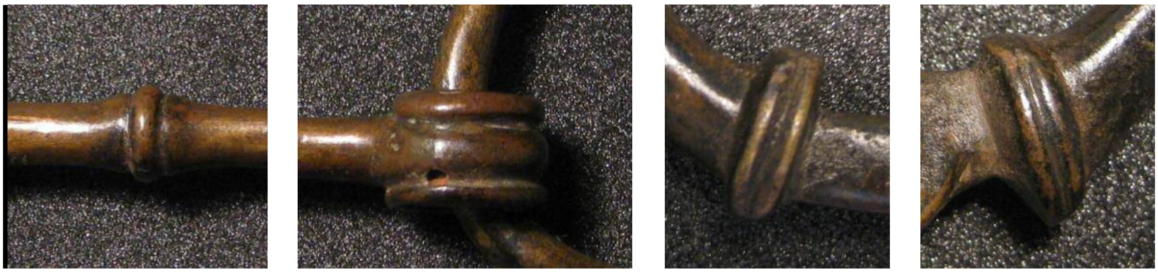


Figure 9. 36: examples of cast in 'ribbed' features on bridle-bit FA 70 (central bar and ring junction) and terrets FA 60 and FA 59 (demarcation between terret ring and bar)

Patination?

The vast majority of objects in the hoard show some degree of black surface patination, best preserved in recesses where it is most difficult to remove; it lies directly over the copper alloy coloured metal, in itself only displaying a dulled slightly oxidised surface. The use of deliberate patinations to add visual effect and potentially stabilising qualities to a newly cast surface is possible, and has been argued as likely for some of the objects from the Polden Hill hoard (chapter 6). However, here there are no obvious distinctions between different types, styles or groups of objects exhibiting different surface coloration in the Middlebie hoard. It is impossible without further examination and analysis to know whether the black surface was related to the burial environment, and has since been removed by cleaning (which seems the most likely scenario for these objects), or was a deliberate surface blackening.

Figure 9. 37: Areas of black surface patination on the reverse of the bridle-bit FA 71, and on the terret FA 59

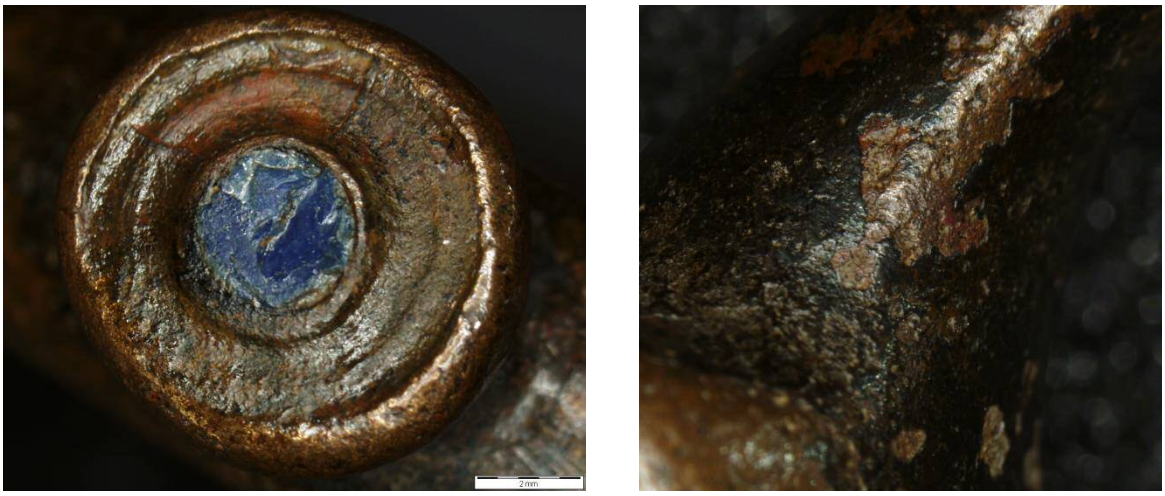


Figure 9. 38: micro-photographs of the platform terret FA 58; the red area underlying the black patina and surrounding the blue appears to be cuprite (indicative of corrosion formed in a reducing environment). The colour and form of the overlying black surface patina can be seen in the detail of the terret ring (photographs: ©National Museums Scotland).

Conclusions

The composition in relation to artefact style, though more complex than in the Seven Sisters and Stanwick/Melsonby hoards, nevertheless shows some similarities in pattern. General observations show that from the 31 objects analysed (including three separate components from each of the bridle-bits), there are several main alloyed compositions:

16/31 objects are leaded bronze (Sn>2%; Pb>1%)

7/31 objects are bronze (Zn<2%; Pb<1%).

3/31 objects are brass (Sn<2%; Pb<1%).

5/31 objects are gunmetal (Sn>2%; Zn>2%); of which a further three are leaded gunmetal (Pb>1%).

These relationships and the composition of the objects are illustrated in the ternary diagram below (figure 39).

Within the red circle are the brass objects: these consist of the enamelled strap union (FA 55), the elaborate ring on the three-link derivative bridle-bit (FA 71) and one of the simple terrets (FA 60). This group matches similar objects from different provenances well, and corresponds to what have been called 'geometric 'Late Iron Age style objects (GLIA) in reference to the Seven Sisters hoard and other brass and polychrome enamelled objects from elsewhere (Davis & Gwilt 2008). Objects within the green circle represent those predominantly of bronze; the composition most commonly used for traditional Late Iron Age objects, including those of 'curvilinear' forms, and objects containing sealing wax red glass. Within this group are all the simple terrets (FA 61, 6-68) except the brass one (FA 60); the button and loop fastener with the excised cell for glass (FA 52), and the link and one ring from the single-link bridle-bit (FA 70). Although largely undecorated, the object types and styles fit comfortably with other Late Iron Age objects of bronze. Therefore both the red and green circled areas represent the use of relatively pure bronze or brass, often seen with horse material from this period, for example in the Seven Sisters (Davis and Gwilt 2008), Stanwick/Melsonby (Dungworth 1996) and Polden Hill hoards (chapter 6).

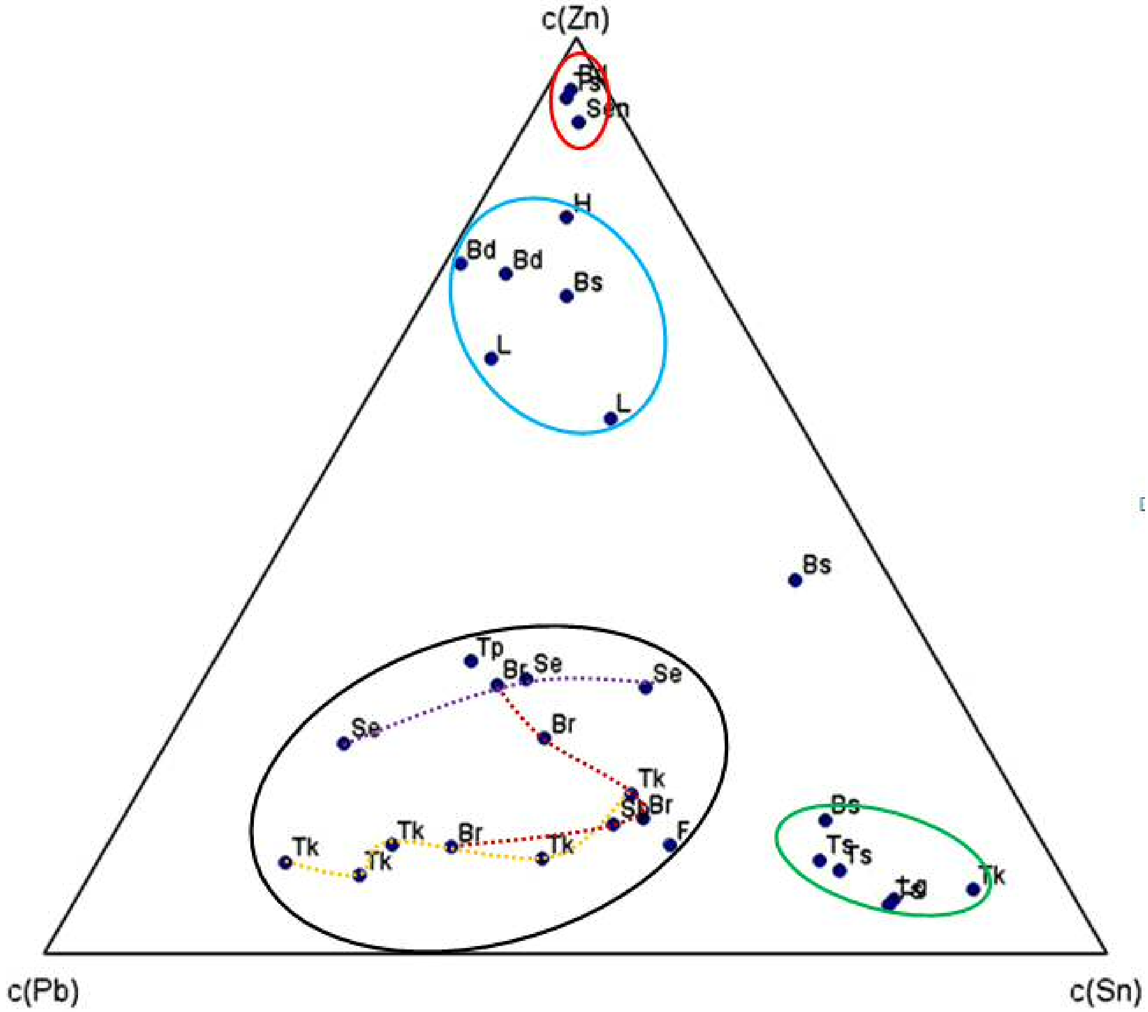


Figure 9. 39: Ternary diagram (centred) using quantities of tin, lead and zinc to group object types from the hoard. (**B = bridle-bit:** r=ring only; d = three-link derivative; s = single bar. **T = terret:** p = platform; k = knobbed; s = simple. **S = strap union:** en = enamelled; b = bossed; e = elongated. **L = button and looped fastener**; g = with glass inset. **F = strap fastener**. **H = hilt guard**.

The black circle contains the majority of objects from the hoard, but many of these can be grouped; they contain all three elongated strap unions (FA 49-51; purple dotted line), all four of the bridle-bit rings (FA 45-48; red dotted line), and all the knobbed terrets (FA 59, 62-63, 65-66 orange dotted line), except for FA 64, the bronze 'pair' of FA 63. The three further objects in this group are the platform terret (FA 58), the bossed strap fastener (FA 69), and the bossed strap union (FA 56). It can be seen that these objects could all be associated with the northern boss style, and although they differ in detail by appearance and composition, on a broad level they are made from similar alloys.

The blue circle largely contains 'gunmetal' artefacts which are the pair of button and loop fasteners (FA 53-54) three components from the bridle-bits FA 70-71) and the hilt guard (FA 57). The addition of lead could help in the casting process, but could also dull the colour of the bronze. The use of gunmetal is relatively rare amongst objects from the LIA hoards.

It does appear that overall there was less strict use concerning the purity of metal alloys in this hoard than in horse equipment from the other Late Iron Age hoards studied here. The accidental inclusion of small amounts of lead, tin and zinc in so many of the pieces, as well as significant deliberate addition of these elements in some of the objects, does imply a less selective use of alloys, and perhaps a greater acceptance of the use of re-cycled material. If the burial of the Late Iron Age hoards was a direct response to imminent Roman invasion, It is likely that this hoard was deposited slightly later than those further south, and that the use of unalloyed or newly alloyed metal was harder to come by, possibly as a result of longer distances or different, less direct or more disrupted trade routes. It might also have been realised by bronze smiths that the non-deliberate addition of minor tin, and lead contents occurring within available alloys could inadvertantly help to make manufacturing easier, and so was deliberately used or selected for pragmatic reasons.

Another related observation of the change of approach to metal artefacts might be gleaned by the fact that some of the objects had solid filled bosses, rather than carefully cast hollow backs. The latter, such as with the bridle-bit bosses, would have required finer craftsmanship, have taken more time and skill to achieve and would use less metal. The use of flat-backed filled bosses potentially shows the beginning of a shift of attitude, where the availability of metal was prevailing over the time and skill of the craftsman. Within the Middlebie hoard there are certainly a number of noticeable miscast objects which appear to have been finished and used, such as three of the five strap unions and one of the bridle-bits. Attention to detail in colour, design, and motifs were possibly not scrutinised or understood within conversant groups of society to such an extent as before; (those members of society referred to by Giles (2008) and Joy (2010) when describing the effect of the Kirkburn sword or decoratively scribed mirrors on people in close proximity to the objects). This shift in metal use and scrutiny of design could also be paralleled with the breakdown of distinct La Tène art motifs in the first century AD (Davis and Gwilt 2008); such decoration is hardly evident at all within the Middlebie hoard.

Recently, Mansel Spratling (unpublished 2011), has looked at variability in style to try and identify the number of different harness sets which may have been included in the Middlebie Hoard. He also examined the Muircleugh group (where a similarly mixed group of terrets have been analysed (Dungworth 1996 419; MacGregor 2 59 and 94-97), and the Stanwick/Melsonby hoard; within the article he also references the Saham Toney, Seven Sisters and Polden Hill hoards. He estimates that there were a minimum of 12 and a maximum of 18 sets (Spratling 2011, 7) present for Middlebie. The variation in analytical composition does not refute his argument, although It is also clear that the compositions of single, but multi-component artefacts, such as bridle-bits varied considerably (e.g. Dungworth 1996; Polden Hill chapter 6; Seven Sisters chapter 7) due to the casting-on process. However, his inference that the original number of chariots extant at one time must have been very large, as each style of component within a hoard represents a potential 'set', does not necessarily stand. He argues that the criterion for the selection of items to make up hoards such as Middlebie was difference, 'stylistic differentiation and that representing individual sets of chariot equipment' (Spratling 2011 28) with one 'representative' often deemed as adequate as several within this context of deposition. Age or use was not of significance, as old and new examples of objects co-exist in the hoards.

What Spratling's study does confirm is that the selection of chariot equipment for burial within these hoards, whether old or new pieces, or with other functional categories, although apparently arbitrary, is a real phenomenon (Spratling 2011 29). He puts this process of selection down to social contract, but with an emphasis on dues or rents to those in authority, citing known kings or queens mentioned in Roman texts describing events of the Late Iron Age in Britain. He defines social contract in this context as 'the general relationship between subject and ruler and subject and subject which structures everyday life'. This thesis would argue for a less hierarchical set of relationship as regards the people making up and disposing of hoards. Chariot and similar equipment did denote a type of currency in this context, but one which was being buried rather than given as tribute, therefore cementing a contract between various living people or groups of people and an unknown, but presumably supernatural entity. This phenomenon was occurring at a time of complex and desperate social change, often involving protracted warfare. Although southern and eastern England had recognised powerful individuals and royal dynasties influenced by Rome (Creighton 2000), there are equally large areas with less evidence for political influence or contact and where there are no named war lords, kings or queens for much of the conquest period.

Equally significant when interrogating the composition of the hoards is that the use of different styles within a single deposit could represent the accumulation and development of harness sets over a length of time, potentially with recycling to the melting pot or another owner, or as components of another object. Earlier within the Iron Age, chariot burials certainly suggest this was happening within the funerary context of disposal. Although many chariot burials show distinct bridle-bit and terret sets accompanying the vehicle, there are also examples showing cannibalisation of pieces to provide a useable or complete set – including different wheels/tyres/ and terrets etc, (Giles 2012, 203; Carter *et al.* 2010). If we also consider the disposal of some artefacts within burials such as the Kirkburn sword (Giles 2008), it is clear that burial of old and curated objects was occurring simultaneously with newer artefacts. Within the Late Iron Age hoards it could be argued that such 'sets' of individual objects and even components of objects could have been retained as a physical memento of past owners/communities or functions, which were later deposited in a hoard due to that element of their significance. In this respect, trying to assess the number of original 'sets' represented may be misreading as to how the sets - if that is what they were – were built up, established and used during the objects' life; the collections of items found together could represent a long tradition of curation and use seen in both Middle and Late Iron Age contexts. It could be argued that deposition of certain artefacts, whether within a burial or in a hoard, entailed giving and disposing of something of significance at a time of change and stress (Huntington and Metcalf 1979).

Chapter 10. The Significance of Horses

'From the perspective of Celtic art the major artefacts fall into two classes; those connected with the human body and those connected with horses and chariots' (Garrow and Gosden 2012, 146).

A large proportion of the objects from these hoards are associated with the use of horses. This chapter looks at a range of evidence for the use and significance of the horse in Iron Age societies, with a view to both understanding their importance and that of the related surviving material culture from the period.

Evidence for horses in Iron Age Britain is diverse. There are written classical sources, especially informative for the use of horses in warfare (Polybius, Caesar, Tacitus); faunal remains in graves and pits (e.g. at Danebury); horse gear buried and hoarded (e.g. Stanwick/Melsonby; Polden Hill), as well as an increasing number of stray finds (many reported through the Portable Antiquities Scheme, for example the strap unions from Alltwen and Maendy now in the National Museum of Wales). Horse imagery is also used in the Iron Age in a variety of ways (see below), for example as depictions on coins, horse figurines, such as those from Gower and Abercarn, plus other artefacts such as the Capel Garmon firedog.

Figure 10. 1: Iron Age horse imagery: from left to right: horse head mount from Stanwick/Melsonby (©Trustees of the British Museum); Capel Garmon Firedog; figurine from Abercarn (©National Museum of Wales); Gold Coin from Henley Hoard (©Ashmolean Museum, University of Oxford).

In this study, all the major hoards examined contain a significant amount of horse equipment. 'There is no doubt that horse-gear and chariots were used as media for display and symbolism in just the same manner as weapons and shields. This is demonstrated both by their inclusion in graves and by the decoration on harness and chariot fittings' (Green 1996, 107)

One way to gauge the significance of horse equipment within Iron Age societies is by examining the context in relation to other prestige items from the period. If the importance of horses and associated paraphernalia in ritual practice and geographical location is examined, there are many links with weaponry and status. The inhumation cemeteries of east Yorkshire, though largely unique in Iron Age Britain, are known for their 'chariots' or 'carts', which include elaborate, and presumably ceremonial, trappings (Stead 1991). As with the swords deposited in some of the graves (Giles 2008), there is also evidence of age, use and repair for the horse fittings as with the Ferry Fryston burial (O'Connor 2009). Whether of practical use, or made from cannibalised parts, battered chariots or carts, and the associated metal horse trappings, were obviously of emblematic importance which could equate with outstanding artefacts such as the Kirkburn sword. Artefacts from sites such as Llyn Cerrig Bach can be paralleled with wealthy Yorkshire barrows, watery deposits and with later hoards; amongst recovered artefacts are horse and chariot trappings, swords, shields and spears, and animal bones. Therefore, within a depositional context, horse gear can be paralleled with some of the most finely made prestigious weapons, shields and other artefacts spanning a significant part of the Iron Age in Britain, whether found in lakes, rivers, hoards or burials. It is argued that horses in the Iron Age need to be considered as highly significant and symbolic.

The use of horses and horse trappings is a thread that runs right through from the Late Bronze Age (Miles *et al.* 2003 78) to the Late Iron Age and the Roman conquest. For the latter two phases, where horse gear seems to symbolise a conflict between old and the new, finds of horse harness equipment, occur in areas of Britain committed to resisting Rome (e.g. Santon and the Iceni, Seven Sisters and the Silures, and Stanwick/Melsonby and the Brigantes). In this respect, the use of chariots, drawn by two horses might be emphasising traditional Iron Age customs, in direct contrast to the use of single riders on horseback; an equine symbolism that Creighton (2000, 16-19) feels was associated with early British 'comitatus' and warrior bands in England. He believes they rode on horseback, and encouraged the use of issued gold coins. This was followed by the establishment of ‘obsides’ (following Caesars invasions), and a Romanisation of coin iconography to show named leaders or kings, naturalistic horses very different to the earlier stylised ones, and newly coloured gold alloys (Creighton 2000, 55; Van Arsdell 1989, 506; Northover 1992, 240; Cowell 1992).

War status

There is a very famous description of the Gauls in battle, and the initial use of chariots in warfare as a vehicle for carrying warriors to the battle field

‘In their journeyings and when they go into battle the Gauls use chariots drawn by two horses, which carry the charioteer and the warrior; and when they encounter cavalry in the fighting they first hurl their javelins at the enemy and then step down from their chariots and join battle with their swords’. (Diodorus Siculus V 29, 1-5; trans. C.H. Oldfield)

Accounts in Caesar and Tacitus of chariots used in warfare in Britain in the first centuries BC and AD imply some anachronism in their use; Caesar himself notes that his men were ‘dismayed by the novelty of this mode of battle’ (Caesar IV, 34), and here the use of horses and chariots could be interpreted as a statement of cultural identity by the indigenous population. The ‘style’ of war in later prehistory changed from the elite warrior societies depicted in Bronze Age Europe (most vividly in the accounts written of individual confrontations in Homeric legend) (Smith 1925), to battles involving the collective (though possibly still elite in some terms) members of a group. Warfare itself was often a ritualised activity, and it is likely traditions and rituals were maintained and adapted to fit the necessary modifications to warring techniques. This is probably what is implied by the pre battle warrior status witnessed by Caesar in Britain.

‘firstly, they drive about in all directions and throw their weapons and generally break the ranks of the enemy with the very dread of their horses and the noise of their wheels; and when they have worked themselves in between the troops of horse, leap from their chariots and engage on foot. The charioteers in the mean time withdraw some little distance from the battle, and so place themselves with the chariots that, if their masters are overpowered by the number of the enemy, they may have a ready retreat to their own troops. Thus they display in battle the speed of horse, [together with] the firmness of infantry; and by daily practice and exercise attain to such expertness that they are accustomed, even on a declining and steep place, to check their horses at full speed, and manage and

turn them in an instant and run along the pole, and stand on the yoke, and thence betake themselves with the greatest celerity to their chariots again' (Caesar IV, 33; translation McDevitte and Bohn).

Chariot fighting is also briefly commented on by Tacitus, who implies this was secondary in its importance in battle 'Their strength is in infantry. Some tribes fight also with the chariot. The higher in rank is the charioteer; the dependants fight' (Tacitus Agricola 12). Interestingly, this emphasises the importance and elite skill of horsemanship, rather than that of the fighting warrior. It should be noted that Caesar regularly refers to the use of Gallic cavalry in war (e.g. Caesar 5.3), but this is not something noted in similar terms in relation to Britons.

The use of chariots in warfare therefore displayed their owners' indigenous affiliations, demonstrated their skill in horsemanship and in driving chariots, and possibly also showed wealth and rank in possessing horses, charioteers and the chariot gear itself (although this could be interpreted as collective wealth rather than that of an individual). It could also have had a psychological effect in battle, by the noise, and speed of the horses, and the use of unfamiliar tactics (Green 1992, 86). It is impossible to know exactly how much the use of chariots was a pre-war ritual with powerful religious as well as status implications, and a rallying call from warrior leaders. The use of chariots against the Romans in pitched battle was probably of limited practical use apart from transport and physical blockading. It worked well for harrying smaller enemy groups of soldiers in the fields collecting grain 'they killed a small number, threw the rest into confusion, and surrounded them with their cavalry and chariots' (Caesar IV, 32).

Green concludes that: 'The esteem with which horses were regarded stems, above all, from their use by the aristocracy as war-horses or for display.....Other indications of the prestige enjoyed by horses include lavish harnesses and the fact that horses are not particularly useful in economic terms, being expensive to maintain and unsuitable for heavy traction' (Green 1992, 72).

Indigenous versus classical

A degree of wealth, in the past as well as the present, was needed to own, train and maintain horses; and 'the three main uses of horse-riding in antiquity were for sport, hunting and warfare' (Green 1992, 66).

Caesar describes 'knights' from Gaul as a noble stratum in Celtic society. 'These, when there is occasion and any war occurs ... are all engaged in war. And those of them most distinguished by birth and resources, have the greatest number of vassals and dependents about them' (Caesar VI 15). A classical analogy might be the 'Hippeis' of classical Greece or the 'Equites' of ancient Rome. These had a particular social standing above the majority of citizens, even after the 'Equites' usefulness as cavalry within the Roman army became relatively limited; the Romans tended to recruit cavalry for use in warfare from provinces with a 'strong indigenous tradition of cavalry fighting, most particularly Numidia, Spain, Germany and above all, from Gaul' (Green 1992, 79). However, there must be some caution when applying classical analogies to the structure of the indigenous British peoples. Creighton argues quite convincingly that the image of a ridden horse was an imported one, and that such 'riders' were deliberately differentiating themselves culturally and socially from much of the population and their customs (Creighton 2000, 11-21). This would suggest the use of chariots and chariot equipment was important to a different section of the population.

Roman interpretations of hierarchical and stratified societies reflect their own customs and should not be relied on for assessing the context of horses and chariot use in many parts of Iron Age Britain. It has been argued by Hill (e.g. 2011) and by Sharples (2010) that society in the Middle Iron Age was organised on very different grounds, and with distinctly less layered social structures. For example, in the hill fort societies of Wessex there is very little evidence for elite goods or prestigious houses. Aside from some of the Yorkshire interments, where the burial of prestigious goods with individuals is also open to alternative interpretations (Giles 2008, 68), there is very little evidence of associations of material wealth with individuals. It could also be argued that horses and related gear were maintained by parts of the community rather than by individual ownership. This argument could also be used for Later Iron Age British societies, particularly those that resisted 'Romanisation' in the first century AD, and which lie predominantly outside the southern and eastern areas of England.

Sacred horses

As well as the status and associated symbolism of horses in military contexts, their importance in more overtly religious or ritual settings is also significant.

The presence of horses used for sacrifice and with burials, as well as in pits and ditches are well attested in Continental Europe (Green 1992, 113-116). The formal burial of horses themselves is rare in Britain, with one of the main exceptions being the metacarpal and metatarsal from the Kings Barrow, Kirkburn (Legge 1984). These belonged to a typically small horse of the type believed to have pulled chariots or carts, and are unlike the horse burials which appear to date from the Early Roman period (first to second century AD) (Stead 1991, 27), when larger animals used for riding rather than pulling chariots are present (Legge in Stead 1991 144).

It could be extrapolated that horses were usually represented in burials by their chariot and harness equipment rather than interred themselves (Green 1992, 115). It is interesting to consider here whether the later practice of hoarding horse equipment, prevalent in areas of Britain where burials are not recorded, (chapter 9; 11), is an instance of a symbolic representation of the horse.

Although horses are rarely found in formal burial contexts in Britain (which are in themselves rare occurrences in most parts of the country during the majority of the Iron Age), their skeletal remains are found in other contexts. In Wessex, an area intensely studied and with abundant data, it has been shown that the proportion of horses buried in pits overly represents their numbers in the general population. This has in turn allowed more detailed studies of horse husbandry and ritual deposition, which give further insights into the use and perception of horses by British Iron Age societies.

The horse itself was treated in a distinct way; Hill (1995), found that horses and dogs were disproportionately represented by articulated/associated bone groups; and that wild animals, if present, were also likely to be placed as special deposits. He suggests 'that horses may have had a special status at this time, being regarded as on the boundary between domesticated and wild animals, between culture and nature in the same way as humans' (Hill 1995, 104; Miles *et al.* 2003, 78).

Danebury, in particular, has allowed for much study and interpretation of horse remains. Grant *et al.* (1991), commented on the condition of the horse bones, and regarded the deposits of a proportion of these as 'special'. Some horse bones were buried with their flesh still attached and lacking evidence of butchery in contrast to most other animals. Sometimes butchery marks were seen, and they suggest horse was eaten occasionally. However, they conclude that 'attitudes to the horse seem to have been very different to the other domestic animals' (Grant *et al*. 1991) and that ‘The frequency with which their bones occur in apparently ritual contexts also suggests that horses may have held a position of higher status than cattle sheep or pigs and were only exceptionally a source of food, perhaps in particular need or even to celebrate particular occasions’ (Grant *et al.* 1991, 522)

The study of depositional practice in the Iron Age in Wessex was expanded by Richard Madgwick (2008). He re-examined the human and animal bone assemblages from several Wessex sites (especially Danebury), and undertook statistical analysis of physical aspects, such as the degree of gnawing, weathering, abrasion and trampling. Through this analysis he was able to discern the special treatment of human remains and horses, within pits in Wessex. His analyses showed that the remains of humans and animals were treated differently prior to burial; human remains appeared to show significantly less evidence of exposure. He goes on to argue that there was a demonstrable difference between the weathering of horses and dogs compared to other animals, where the former showed greater evidence of 'sub-aerial exposure'. Evidence for gnawing produced a complex hierarchy; other animals exhibited more gnawing in features containing only animals, but horses (and dogs) showed more in features which also contained human remains. Although the results are complex, Madgwick believes that there was a level of statistical significance to suggest an intentional degree of difference in the treatment of dog and horse remains in distinct features (Madgwick 2008).

Again, as with hoarding in the Late Iron Age, there may be a tangential link in cultural thinking and practice between different types of burial, whether in graves or pits, or whether containing humans, animals or artefacts, despite chronological and geographical differences. Green, commenting on placing offerings in pits suggests ‘Such a ritual act would be at one and the same time one of gratitude, appeasement and a rite of passage at a time of change’ (Green 1992, 103). All issues which could be equally relevant at a funeral, or at the ritual deposition of artefacts into water, or as hoards at a significant or stressful time for a community (Huntington and Metcalf 1979).

Domesticated horses?

Examination of the horse remains from Wessex has also led to inferences about the treatment of horses before their death and deposition.

Harcourt (1979) and Grant (1984, 191) in particular have researched this aspect of the horse in Iron Age Britain; again much of this evidence comes from Danebury (Harcourt 1984, 521), but also from other sites such as Gussage All Saints (Harcourt 1979), Longbridge Deverill (Harcourt 2012, 221-4) and Maiden Castle (Armour-Chelu 1991, 145-6). Harcourt does not believe horses were bred in captivity; and commenting on the horse bone assemblage from Danebury (Harcourt 1984, 521), and Gussage All Saints (1979, 158) he remarks on the conspicuous scarcity of the bones of young horses compared to the bones of other young animals, which were common. ‘The evidence for the age of the horses at Danebury suggests there was no breeding of horses actually on the site’ (Harcourt 1984, 521). In his discussion of the evidence from Gussage All Saints, Harcourt goes on to suggest that horses, in Wessex at least, were not bred during the Iron Age but 'were periodically rounded up to be broken in and trained for riding’. Harcourt gives good reasons for such a practice; horses are not suitable for work until they are at least three years old, so acquiring them nearer this age obviates the need for care, food and other resources before the horse matures enough to be of use. He also argues that weaker specimens would be weeded out by natural selection (Harcourt 1979, 158).

This again reflects the liminal status of the horse as a 'domestic, feral or wild' animal, further emphasised by its special treatment as such in the burial contexts (discussed above) (Harcourt 1979, 150-60). Further evidence for this can be gleaned from Grant's observation that the horses from Danebury were predominantly male in a ratio of approximately two to one (Grant 1984a, 521); and if they were being rounded up, this would imply a preference for males; not usually notable for animals kept and bred in captivity.

The status, use and treatment of horses is again inferred by differences in their bone assemblages to that of cattle at Danebury (Grant *et al.* 1991) and Gussage All Saints where there is a 'high proportion of entire long bones' (Harcourt 1979, 153). The far higher proportion of unbroken horse bones could suggest the relative maturity of the horses at the time of death, in contrast to cattle dying before their bones were fully fused. This again reflects the lack of juvenile horses present at the site (Grant *et al.* 1991).

All these arguments confirm the elite and specialised nature of horses, which would probably have been kept mainly for riding and pulling carts or chariots. Grant *et al.* (1991) believe that until the Saxon period and the development of the harness at that period, horses would only have been able to pull light loads. In this respect horses were of far less economic importance than other domesticated animals present in the Iron Age. In contrast, cattle would have had to provide all the heavy traction, were probably cheaper to feed, easier to keep and much more frequently eaten. Horses or ponies could be trained from about two to three years old (Grant 1984, 521), but did not reach full maturity until they were about six years old, and might expect a working life of ten years (Palk 1991, 329). The age range for the death of ponies at Gussage All Saints is three to eighteen years, with an average age of eight to nine years, so Palk's estimate might be optimistic (Harcourt 1979). However, they could be trained to be ridden and to pull chariots, were faster and more versatile, and certainly throughout history (Bucephalus, Incitatus, and Copenhagen etc.) have been invested in, and have held a special place as companions as well as symbols of nobility and wealth.

Horses as symbols of power in the Later Iron Age.

It has been argued that social structures within Britain were diverse and fluid, especially during the pre-conquest period. It is within this framework that Creighton develops a powerful and important argument for the change in use of the horse based on the nature of horse imagery on Gallo-Belgic coins. In a military and regal sphere, horses represented power, and he uses classical sources on Europe and Britain to show how powerful leaders, kings or princeps were establishing retinues of 'Comitatus' at the time of the introduction of these coins. He argues this was occurring when the importance of hillforts was declining (Middle Iron Age to Late Iron Age transition). It is in the late phase of hillfort occupation at sites such as Danebury and Maiden Castle that far more horse bones are found. There is also much more material evidence for horse equipment. Hill similarly argues for the establishment of an emerging class structure occurring at this time: 'the appearance in late Iron Age and early Roman times of the first class-based societies in British history, is a process as significant as the conquest itself (Hill 1995b)

Tacitus describes the existence and training of 'comitatus' on the continent (Tacitus *Germania* 13), and Creighton uses the idea that a similar, newly generated social structure was being imposed on the indigenous population of central southern Britain. Pivotal to his argument is the use of the horse; 'If any one thing symbolised the power of potential rulers and the leaders of comitatus, it was the horse. Not only did the horsemen represent power, but also the horse itself may have been ritually significant in its own right' (Creighton 2000, 22).

'The social control of central-southern Britain appeared to be changing. Perhaps we might be moving away from our 'egalitarian' hillforts and towards a landscape managed, ruled and terrorised by new leaders with faithful followings' (Creighton 2000, 17). The adoption of the horse by an individual, and the act of riding rather than driving a cart or chariot could be seen as a way of legitimising and empowering the position of influential and controlling individuals. The ploy of emphasising the use of horses and their imagery was very deliberate; it invoked strong indigenous symbolism, previously associated with communities. Creighton (2000, 18) also argues that a number of the relatively novel 'oppida' were being established in valley bottom locations, many enclosing or including large meadow areas which were useful for watering and feeding horses. Sites such as Silchester were converted from woodland to pasture, but not for arable use. It appears that in the later second century and early first century BC, horses began to be used and associated in southern and central England in a context of Roman goods, trade, slavery and new power bases: 'I imagine the Middle to Late Iron Age transition as a far more violent time, for at least a short while as new forms of authority were established' (Creighton 2000, 20). Grant's study of the horses from Danebury notes that later assemblages of horse bone were more uniform in size, slightly smaller, and with more juveniles present, implying the possibility of a change in husbandry patterns (Grant 1984, 521-523).

Interestingly, this is also the period when gold coins were introduced, and when horse imagery on coins takes off. Coins were a convenient and portable way of transmitting ideas of power and symbolism, (and later of individual authority). They were often deposited in hoards or as single items, and as such make up an important element of earlier hoarding practices; but do not tend to appear in later hoards, where actual horse equipment is so dominant (Garrow and Gosden 2012, 167-8). The significance and symbolism of horses and coins is discussed in detail by Creighton (2000). The use of coins in the Iron Age was never established in many areas of northern and western Britain; whether this was a deliberate rejection of coins as portable art, the unavailability or rejection of precious metals, or a negative response to this method of transmitting symbolism and status is impossible to say; but it should be recognised as a significant refutation by some sections of Britain, especially when considering the strong correlation with areas resistant to the Roman conquest in the first century AD.

Horse numbers

There has been much speculation about the numbers of horses or ponies kept by Britons in the Iron Age. Gosden and Hill produce figures for the potential numbers of horses, and by deduction, the number of chariot fittings; they do qualify these estimates as 'obviously an exercise in speculation' (Gosden and Hill 2008, 7). They use a pared down approximation from Caesar's estimation of the number of chariots mustered by Cassivellaunus in 54 BC; Caesar mentions 'about 4,000 charioteers'. They also use the exceptional collection of moulds from Gussage All Saints: 'It seems likely that about fifty sets of pony-harness and chariot-fittings would not be an unduly wild estimate' (Spratling 1979, 140). From these sources they come up with an estimate of one chariot for every fifty people, or perhaps more relevantly, one for every extended family or group of four to five households (Gosden and Hill 2008, 6). If it is estimated that about fifty people lived in an average Iron Age enclosure (Niall Sharples pers com.) and that this could represent a large extended family or a community or group, Gosden and Hill's estimation could fit well with one assessment of social structure. If horses and chariots were kept within this relatively egalitarian world of the Middle Iron Age, we might model from this some of the potentially more conservative practices maintained in later Iron Age western and northern Britain. The responsibility for approximately one pair of ponies and associated equipment by a small settlement in an agriculturally dispersed and settled landscape would make sense. Alliances and disputes would be played out on a relatively localised level but this would also allow larger alliances to be formed, for example in resistance to hostile armies. The horse paraphernalia was for the symbolic show of rights, power, and land occupation as much as, if not more than for functionality. These items became essential in maintaining social systems, disputes and cooperation where necessary. The horse equipment itself represented a social currency recognisable within a diverse society, which was used, and then deposited in significant ways, such as when buried in hoards. This theory is also relevant when looking at other artefacts within Late Iron Age hoards such as tankards and vessels which have not dissimilar social and communal connotations.

Related to the keeping of the horses or ponies, is the production of the chariots and related horse gear; the question of the organisation of the type of industry employed for their manufacture in the Iron Age is unresolved: it is not known how many specialist craftsmen existed, where they were based, or how peripatetic they were (Spratling 1979, 141; Gosden and Hill 2008, 5). The number of moulds at Gussage and the relative similarity in style and decoration of material buried together in a hoard (i.e. Polden Hill), could indicate one relatively large set of casting episodes designed to supply a number of communities within a specific geographical area.

All this is complicated guess work, especially assuming that we are seeing a small and exceptional part of the original number of items from the Iron Age occurring in the current archaeological record. Much of this survives as a result of 'unusual events' such as the burial of special deposits in hoards (Gosden and Hill, 7). However, the evidence could account for the co-ownership and responsibility for the semi-wild horses and other domesticated animals, which occupied relatively large tracts of land that could have also been used for the subsistence of a number of small community groups. It would express the community's prestige via 'ownership' within the proximity of neighbouring groups. In this sense it could be paralleled with elaborate hillfort 'defensive' ramparts and entrances, which are argued to be a means of binding the community together through the building and maintaining of ramparts (Sharples 2012). These were also a symbol of power, rather than merely possessing the practical function of defence.

It is also worth considering that ownership of horses or ponies within a group would have many advantages. Resources including 'expense', time and skill, all attributes needed to harness, herd, train and drive chariots, could be more easily met within a group than by a relatively wealthy individual dependent on a variety of people with such skills. The latter model may have become the custom with leaders and commitatus for some locations as discussed above; but the former means of organisation and ownership makes more sense for the majority of the Iron Age in many parts of Britain. This could have been the norm in the Middle Iron Age and within certain more geographically peripheral areas across Britain in the Later Iron Age, accommodating variable populations as well as numbers and types of settlements.

If horses were rounded up and trained as Harcourt interprets (Harcourt 1979), there would have had to be large areas where herds of semi-wild horses or ponies could live, and suitable land would not necessarily be in proximity to settlements. It is also worth noting here, that although very prominent in terms of surviving material culture, how much smaller the proportion of horse to cattle is in bone assemblages from sites such as Danebury, even considering a steep increase in numbers in the late Iron Age phases (Grant 1991); horses were relatively rare.

Conclusions

It is clear that the horse was of huge symbolic importance to many divergent Iron Age communities across Britain; their status can be clearly seen in the archaeological record from the quantity and treatment of surviving bone assemblages, their 'special' burial status and by the large representation of high quality materials and 'art' invested in the manufacture of horse equipment; there is also a range of significant imagery from that on coins to the White Horse at Uffington. Horses were perceived as special: half wild/half tamed beings. The materials used for horse harness, and the use of objects as a vehicle (sometimes literally) for high status 'art' emphasised the importance of these animals and their 'ownership' across much of Iron Age Britain; this was expressed by giving a nationally recognisable and understandable identity to this animal and its significance.

This widespread symbolic currency meant that the treatment of horses, and their imagery was a significant route used by divergent groups to display either indigenous identity against a new class-conscious ruling elite, or by relating horses with new ideas and materiality linked with wider connections to the classical world, and later more direct association with Roman practices (Creighton 2000).

In the Middle Iron Age it has been argued that horses were cared for and 'owned' communally. This would fit with what is known about well excavated parts of Iron Age Britain, such as Wessex, where there appears to have been a communal creation and maintenance of hillfort and enclosure boundaries (Sharples 2011, 116), communal storage of food, and communal ritual burial in pits, in tandem with a suppression of individual identity; but with little evidence of hierarchy (Sharples 2012; Hill 2011). As the later Iron Age developed, and we take into account that 'varying political structures could easily have existed in different counties in Britain, and the situation before Caesar could have been extremely fluid' (Creighton 2000, 13), there may well have been a growing range of ways in which horses or ponies were kept, maintained and used. In many areas outside the direct influence of Creighton's southern Commitatus, or the much greater continentally and Roman-influenced south and east, traditions of communal ownership could have been maintained and used as a means of maintaining old style alliances between local areas when under threat from outside; this in fact may well have entrenched beliefs and customs in the first centuries BC and AD.

The possibility that horses were communally owned, i.e. part of a flatter social order (Hill 2011), would provide a different emphasis to the interpretation of much of the surviving harness equipment, with repercussions for both its 'ownership' and burial, particularly within the hoards of the Middle to Later Iron Age. It would explain the deposition of hoards containing horse equipment as a communally significant event. This opens up many other questions: were other non-horse related objects within such hoards (especially in the Late Iron Age), such as brooches or vessels, representing different types of community, or different strata within that community as values, even within conservative areas of Britain, were slowly altering? For example, did personal belongings such as brooches represent an individual in contrast to a community, or an individual not able to, or not wanting to buy into the ‘ownership’ of horses, but still indicating allegiance and alliance. The variation, though limited, within these hoards could illustrate the loose messy alliances felt to exist amongst the native population at the time of Caesar’s invasions.

The burial of hoards, possibly in liminal locations (Hingley 2006) with no known individual associations attests to the continuation of a mode of communal ownership into the Late Iron Age in some areas of Britain; especially those in direct conflict with the Roman army. The vast numbers of chariots and fittings postulated to have been owned and made, inferred from extrapolation of the archaeological preservation of harness pieces and casting debris could more easily be accounted for in terms of collective ownership.

Communal ownership of horses and their trappings puts a different perspective on the nature of hoarding of such material (and by implication for earlier hoards as well). It would sit more easily with a theory of community action and ownership over an important public event, as has been ascribed by Giles (2008) to the burial of ancestral goods in Yorkshire, or to the disposal of items such as the Witham shield, which incorporates the idea of appeasement of gods and the coming together of communities at times of change and stress; events such as these are often associated with the death of a leader (Huntington and Metcalf 1979), or possibly in these cases, a need for war.

Chapter 11. Discussion

The principle aim of the thesis was to examine the technology of Late Iron Age decorated metal work at a time of dynamic change from both internal and external factors. The objects chosen for this study were from hoards, which superficially had aspects in common. They all included horse gear; a proportion of the metalwork was decorated using sealing wax red glass (a specific Iron Age technology); they were buried on dry land rather than as watery deposits and they contained no offensive weapons.

Chemical analysis of objects from this period is important. The first century AD witnessed both technological sophistication and conservatism as the Iron Age metalworkers confronted the introduction, through continental influence and the Roman army, of new materials such as brass, and the re-introduction of piece moulds and leaded copper alloys.

The scientific analyses of metal and glass in conjunction with a detailed examination of the objects, has added a level of complexity and demonstrated associations that are not apparent through visual analysis alone. In previous studies Northover (1984; 1989; 1991; 1999), Dungworth (1996; 1997) and others have sought to identify metal sources, assess both regional and broader scale patterns of use and identify workshops. Similarly, Henderson (1989; 1991; 1995) has accumulated data for Iron Age glass for site reports. The investigations undertaken here have identified object groups and provided detail about how the objects were manufactured, decorated and used. It has also revealed something of how they were gathered together and deposited, the number of people depositing them, and the relationship between deposition and accumulation which enlighten how society was organised in particular parts of Britain.

By analysing a number of similar hoards, but from different locations in Britain, some direct comparison was possible. Similarities and differences could be evaluated, and a broader knowledge of the objects and their use observed. This made it possible to track changes in development across a relatively narrow but significant time period, and across distinct geographical areas.

Use of metal and glass

Analysis of the objects has shown that there is a broad consistency in the use of materials, especially within the Polden Hill and Seven Sisters hoards. For these hoards the majority of objects are horse related and are made of bronze. Some objects are manufactured from brass, but there was no use of mixed alloys; there is virtually no leaded bronze, and no gun metal. Relatively high zinc contents in an unleaded brass would have been difficult to cast (Northover 1999), and would have required a high level of skill, especially when using investment moulds; but in this respect the craftsmen seem to have followed traditional Iron Age working practices, employing brass as they had bronze. A similar pattern is seen for the horse harness equipment in the Stanwick/Melsonby hoard (Dungworth 1996; 1997), where from the four identified sets, three are brass and one is bronze.

The Santon hoard contains a larger variety of both objects and materials, but its position in East Anglia singles it out in several respects, especially by its proximity to Gallo-Belgic influences and trade, and in Prasutagus' client king relationship with Rome. The majority of the objects are bronze or brass, but there is a fair amount of leaded bronze; gunmetal and leaded gunmetal are relatively rare. As with the Seven Sisters hoard, some objects are definitely Roman such as the *Oenochoe* and the *patera* handle, and others are tinned, which was a Roman technology. A number of the brooches are of continental style and imported. This makes it harder to determine whether other less diagnostic objects are indigenous or not. The horse and chariot equipment shows the usual pattern of either bronze or brass, except for three notable exceptions; the quadrilobed strap unions contain small quantities of lead, which would have made casting easier, and the bridle-bit is highly leaded. Although indigenous in design and use, these objects show that metal workers within the Iceni territory were more willing to adopt continental alloying techniques, which might well have been perceived as Gallo-Belgic rather than Roman (chapter 4). The objects do contain significant arsenic levels which suggest indigenous rather than Roman metalworking technologies (chapter 4).

At Middlebie, the hoard is probably slightly later in date than the others; the type of objects deposited are the narrowest in range, and are all horse related except for the sword hilt guard. However, the copper alloys used are not as carefully selected as in the other Late Iron Age hoards. Within the Middlebie hoard the use of leaded bronze, and then unleaded bronze predominate; although the levels of lead in many of the objects are very low and may not be deliberate additions. Where objects are notably traditional in style, for example the 'simple' terrets', these show the purer bronze – brass divide as in the other hoards. There is also an example of brass on the three-linked derivative bridle-bit, and its use here matches the material characteristics of this category of object (appendix 9).

The use of inlaid sealing wax red glass shows a strong pattern to its use. This type of glass uses a specifically Late Iron Age technology (chapter 5), and it is almost exclusively inlaid into bronze items, often in tandem with other decoration to the metal which is Iron Age in character. This pattern has also been seen for the objects from Wales decorated with sealing wax red (appendix 8). There are only two examples where Roman red enamel has been used instead: one is the Rose Ash style bowl from Langstone (Gwilt, accessed 2014), which has an escutcheon inlaid with Roman glass, and the other is the larger half of a horse brooch from Polden Hill (46.3-22.112; discussed in chapter 6).

The Santon hoard has several objects containing red glass, these include a decorated vessel handle and the steelyard which are both pure tin bronze. However, in other aspects this hoard is an exception: slightly leaded bronze is used for the quadrilobed strap unions, and leaded bronze for the bridle-bit, which probably once contained red glass.

The only object which might have contained sealing wax red glass from Middlebie is the ring headed button and loop fastener (FA 52); this has a bronze composition similar to the majority of Late Iron Age cast bronze objects including traces of arsenic, but none of the original glass or enamel is visible through the restoration work.

The use of polychrome enamel is seen on the brass horse pieces from the Seven Sisters hoard, and was probably originally present on the brass cruciform strap union from Middlebie. It is notable that horse equipment made from this newly introduced metal, does not use the traditional inlaid red glass, but enamelling with multiple colours inserted into small cells. The platform terret from Middlebie has a blue glass setting; it is interesting that this object is one of only two types from Middlebie where the metal contains no arsenic.

The Stanwick/Melsonby hoard shows the same use of red glass; it is only the harness set made of bronze that has inlaid red glass decoration; analysis on a piece of this glass at the British Museum showed it was also sealing wax red (Freestone pers. comm.). The fact that these patterns of metal and glass use occur in Wales, Scotland, northern, western and eastern Britain show comprehensive sets of traditions used, maintained and adapted throughout most of the country, and implies mutual contacts and knowledge within a certain strata of Iron Age society, despite the many regional and tribal differences.

This consistency in material use across Britain in the Iron Age is far more strictly adhered to than in the preceding and proceeding periods. In the Late Iron Age it expresses an innate conservatism in the face of rapid technological change; in instances where such changes were adopted , these were also adapted to Late Iron Age methods of production (for example the use of brass with high zinc content and no lead, and for the manufacture of objects such as horse gear). The area where more variety of metal use is seen is for individual items such as brooches, which may have become more readily available to a wider group of people in the first century AD.

Technological conservatism is seen in tandem with the flourishing of Late Insular La Tène art, which although incorporating aspects of earlier Iron Age art developed its own distinctive style in the first century AD, and is seen on objects such as the quadrilobed strap unions. These factors seem to be used to reinforce native customs, practice and identity through the display of traditionally important types of artefact.

Composition of hoards

The ubiquity and importance of horse equipment in all the hoards has been discussed, but there are other themes of importance illustrated by the presence or absence of other types of artefact. All the hoards studied here except Middlebie contain objects related to feasting. The recent interpretation of the bronze bands in the Polden Hill hoard as hoops for a wooden vessel (Jody Joy pers. comm.) are paralleled by other metal bands, such as the iron ones from the Stanwick/Melsonby hoard. The Santon hoard was found in a cauldron, and parts from other vessels are also present. The Seven Sisters hoard contains a number of tankard handles and tightly folded bronze sheets. All these vessels are associated with feasting and drinking as communal acts, and ones which would bind people together.

Another interesting set of objects found in common within Polden Hill, Santon and Seven Sisters is a number of tools, weights, and unfinished objects and scrap metal. It is sometimes difficult to distinguish between broken objects and scrap, but the presence of such items does highlight the importance of the metal smiths to these societies; they are almost certainly negotiating the acquisition of metal as well as producing the artefacts types within particular styles, so their contribution to identity through material culture was pivotal. The evidence from Polden Hill suggests some objects which were made at the same time were then dispersed; several then seem to be gathered together again as part of the hoard. This illustrates not only the cyclical nature of the life of the objects; but the integral role of the metal smith as part of a defined community whose work was circulated and used.

Seven Sisters and Santon also contain identifiable Roman military material; for horses in the case of Seven Sisters, and armour fittings in Santon. The Seven Sisters material is more easily interpreted as captured goods, but a similar representational role might be attached to the small number of Roman buckles from Santon.

Location of hoards

As stated in the introductory chapters, all the hoards of the type studied here were found in regions which were historically attested to be resistant to Roman rule; this in itself fits with the continued use of Iron Age material culture. The exact location of the majority of the hoards is unknown. The Seven Sisters material was washed into a stream after a flood; Middlebie, was found at Middlebie 'Moss', and the Polden Hills would have been a relatively high spot, almost completely surrounded by wetland and saltwater marsh in the first century AD, and in an area between the tribal territories of the Dobunni, Damnoni and Durotriges. Santon is in the Norfolk Breckland, and the modern village runs alongside the Little Ouse, it is probably close to where the Iceni-Trinovantian border area had been. Some of these locations would not have been inhabited, but others might; it is possible that the majority were significant as boundaries in more than one way; several of the locations seem to be close to water which could represent liminal territory in terms of geographical features and areas of religious significance. Hunter argues that votive deposition may have played a role in integrating communities at various levels, but also points out that liminal locations may be neutral meeting places rather than holy places (Hunter 1997, 122).

Gathering and Depositing

An important aspect in hoarding can be inferred from the practice itself. Most locations were relatively remote, or would have been for a number of the participants. The gathering of groups of people would take a level of organisation and planning. The people taking part would have to know where to go, who was expected or allowed to go, perhaps how to find the place, when to be there, and to bring the right provisions for journeying, and the objects for deposition. The act of deposition was presumably ceremonial 'but whether ceremonies were in the hands of [an elite], of religious specialists, or of another segment of the population in unknown' (Hunter 1997, 120).

When discussing the artefacts present in the burial at Baldock, Garrow and Gosden state (2012, 248) that:

'it is possible that their deposition in the ground was part of a continuing political strategy implicating these objects in the assertion of social power; it could be that those who placed them in the grave were consolidating their status by demonstrating their ability not just to acquire these items but also to throw them away'

It seems equally possible that this reasoning could account for the deposition of objects within the Late Iron Age hoards. However, it is equally valid to see hoarding as representing a very different way in which to express societal order through the disposal of material culture.

These hoards certainly seem to represent a gathering of people at an important ceremony at which objects were deposited. This is without doubt different from the votive depositions at Llyn Cerrig Bach (Macdonald 2007) or Fiskerton (Field & Parker Pearson 2003), where there were multiple deposits over a long period of time. For the Late Iron Age hoards, as for burials, the episode of deposition was a single significant event; and like the burial of a major figure within a community or 'kingdom', it probably denoted an important moment within the life of that particular community or group. If the notion of the death of a king or tribal leader is removed, the sentiments for hoarding at a time of political crisis, such as facing foreign invasion, could well echo those of burial. For example, in discussing 'The dead king', Huntingdon and Metcalf say that [Royal deaths] 'often set in motion powerful ritual representations of unifying values, designed to offset a blow that leaves society stricken in the very principle of its life' (Huntingdon and Metcalf, 1980, 122).

There are also physical features that some Iron Age cremation burials, especially the later ones from south east England, have in common with the Late Iron Age hoards discussed here; one of these is burning. Accounts of discovery of the hoards, for example Polden Hill (Brailsford 1975), and evidence from the objects themselves, as with Stanwick/Melsonby and Seven Sisters, suggests a proportion of these hoards were burnt; a destructive and transformational process. Fitzpatrick suggests that 'the placing of people, animals and worldly goods on the funeral pyre and their subsequent transformation by fire was to enable their transferral to the gods not as material goods, but as metaphysical essences' (Fitzpatrick 2007b, 127). The religious or ritual significance of burning and burial, though difficult to interpret, should not be ignored.

The act of breaking objects is reflected in the burial from Lexdon, where it has been noted that many of the objects had been deliberately destroyed (Fitzpatrick 2007b, 135). Partial deposition may parallel Welwyn type burials where often only small fragments of bone from the deceased individual were found buried (Garrow and Gosden 2012, 242), or the partial human remains found in pits and ditches in Wessex (Sharples 2010). There is also a strong link in the practice of burying feasting gear, and different shapes and sizes of these objects strongly signify different social expressions (Wells 2012); whether this is communal feasting or the individual portioning of food or drink (Hill 2007).

It is also worth mentioning that none of these hoards contained offensive weapons; there were shield bosses, a sword chape and a hilt guard present, but no swords, daggers or spears. This is directly reflected in Late Iron Age south eastern burials where 'Weapons were placed in some Welwyn-type cremation burials, but they are almost always defensive weapons in the form of shields, and the burials are late in date' (Fitzpatrick 2007b, 127). This is different from some Late Iron Age hoards such as the South Cave weapons cache, or the Stanwick/Melsonby hoard (MacGregor 1962), (http://www.bbc.co.uk/ahistoryoftheworld/objects/-QPHt5unTM-rsnCNUfkiEA; accessed 2014).

Although often there were considerable similarities both in the single episode of deposition of a hoard, and in the types of artefact deposited in high status burials (for example at Santon, chapter 8), there were important and distinct cultural differences expressed by these separate types of rites, which illustrate a real difference in the organisation of society in different areas of Britain in the mid-first century AD. The burial was a representation of loyalty to an individual; although 'it is important not to assume direct ownership of the material culture within a grave on the part of the person with whom it was buried' (Garrow and Gosden 2012, 246). The wealth of some of the burials could indicate or reflect potential tensions which arose after the death of someone of importance. Families could be vying for land or political power, and funeral rites could reflect these complex layers of social practice (Huntington and Metcalf 1979). Within south eastern British society there were certainly distinct hierarchies, seen by the variation in the richness of burials (Hill 2007), but also by the existence of named kings or rulers (Creighton 2000), who produced inscribed coins, and seemed to have relatively strong relations with the Gallo-Roman and Roman world. However, excluding the southeast and Yorkshire burials and the unusual warrior and mirror inhumations, burial rites lack this visible level of ostentation in much of Britain; the majority are not visible at all in the archaeological record.

Hoarding, although in so many ways paralleling rich burials, can be interpreted as an act of a community coming together, also probably at a time of stress; possibly for the formation or re-affirmation of alliances between discrete communities at a time of crisis, such as in the face of an invasion. Here too, it is important to understand that prestige items ‘may embody group wealth and power; the special paraphernalia of specific social and religious roles and offices representing or serving the whole community’ (Hill 2007, 21). The difference in practising elaborate burial rites rather than hoarding, which appear to be geographically mutually exclusive (Santon chapter 8; Hunter 1997; Hill 2007); could reflect a real social distinction between types of authority; interment reflecting the power of an individual or elite faction, as opposed to that exercised by the community. The latter type of society has been described as ‘transegalitarian’ or ‘heterarchical’ by Hill (2007, 21), where power resided primarily within the community and where positions of power or authority were constantly negotiated; quoting Haas, he refers to them as ‘societies with *leaders* but not *rulers*’.

It is argued here that although increased patterns of change occurring in the archaeological record in the Mid to Late Iron Age and the subsequent Roman invasion were affecting most areas of Britain, the responses varied enormously. One response, which was prevalent in several parts of Britain was the practice of hoarding. Hunter when discussing the northern British hoards states that ‘A link to changes in society seems likely, although hard to define in detail......, the inception cannot be linked to the Romans, but they are invoked here to explain aspects of the phenomenon. If there were already stresses within society, perhaps with pressure on land or other resources, and ritual was used to provide an outlet for these, then the impact of Rome may have intensified this’ (Hunter 1997, 122). Hoarding had certainly been practised throughout much of the Iron Age (Garrow and Gosden); but these particular Late Iron Age hoards and the places in which they are found, does suggest a direct link with resistance to Roman aggression, although perhaps Middlebie least fits the picture.

The type of artefact buried, and the very specific selection of indigenous styles and materials from which they were made, borders on the anachronistic in technological terms; this has also been argued for the use of chariots as a whole (chapter 10). However, their function might have been of central importance in other ways. If a pair of chariot ponies was kept, trained and maintained by small communities or family groups, who were thereby also responsible for the chariot and accompanying horse equipment, this would act to tie them together. If the small communities relied on each other to muster a number of chariots which would have been needed in the past to be effective in battle, and in the meantime to exhibit power and allegiances, these objects would then convey importance to a larger related group. The use of communal vessels for feasting and drinking would form similar functions. The fact that for the Polden Hill hoard, clear artefact styles, as well as metallurgically similar objects were brought together implies that part of this group at least was already connected through the making of these objects. It could also be argued that the ‘one-off’ and original nature of the majority of artefacts made in the Iron Age (Garrow and Gosden 2012, 17) were specifically for communal use. They were important as individual pieces exhibiting a distinctive and recognisable range of ornament and were symbolic for a community and for wider contacts in a society where it has been argued individuals themselves were not normally marked out, whether by rank, personal regalia, living space or burial (Sharples 2010).

Dissimilar, or one off objects, could represent newcomers to a group, as could personal items such as brooches and torcs. There was certainly an influx in the availability of copper and its alloys in the first century AD, and Roman influence, followed by the Roman army and its entourage, seems to have brought with it a democratisation of both attitude and availability to personal ownership of metal artefacts. This is particularly noticeable in the case of brooches, with an evident increase in access to material culture of this type. This influx and use of dress and personal ornament signified a change from communal to personal ownership, and the inclusion of some of this material in hoards, indicate a limited acceptance of change and the need to maintain alliances. Roman objects might have signified successful past encounters with the enemy.

The ceremony surrounding the deposition of such hoards might cement alliances, select a new leader or invoke the help of the gods, but was performed in a comparable manner with strong elements of similarity amongst geographically divergent groups, suggesting a degree of cohesion amongst resistant native Britons.

For the Future

The thesis has included a large amount of metallurgical data which has shown interesting patterns which could be explored by further analysis.

The most divergent use of materials comes from Santon; the nearby Westhall hoard from Suffolk is the last major hoard of this type not to be analysed. It is smaller, and horse gear forms a much higher proportion of the objects. It would be interesting to examine this hoard not only in relation to Santon, but to the other hoards studied. The glass inlays from Santon and Westhall have not been analysed and considering the changes in technology occurring in material from East Anglia, it would be informative to see what had been used to decorate these objects.

Further types of analysis may prove interesting. Lead isotope analysis of the Late Iron Age glass and brass objects from the Seven Sisters hoard might help determine whether local (British) sources were used, and whether the cementation process was practised in Wales. It would also be instructive to know whether native lead and copper were used in the manufacture of red glass; although this might be particularly difficult due to the very mixed lead signature likely to occur. The one piece of sealing wax red glass that has been analysed by this method, the ingot from Tara Hill, gave no definitive results as to the origin of the lead (Stapleton *et al.* 1999), but further refinement in techniques may increase the likelihood of obtaining informative results.

The hypothesis about the manufacture of sealing wax red glass from Late Iron Age or Roman yellow glass needs to be tried experimentally; if it is technologically feasible, it could be an important strand in understanding the indigenous development of the use of glass and enamelling.

The detailed analysis of isolated pieces of metalwork should be routinely undertaken as it is only in this fashion that regional patterning will be distinguished. Work on the objects recovered by the Portable Antiquities Scheme in Wales (appendix 8) suggests regional patterns may be recognisable.

General Conclusions

Composition of objects in hoards

- There was a broad similarity of form, decoration and mode of deposition in Celtic art across Britain in the Late Iron Age.
- The similarities included a level of conservatism in the selection of materials; predominantly unleaded bronze was used, and when inlaid, this was with sealing wax red glass.

- Where the introduction of new materials like brass and polychrome enamel did occur, the types of object made were often similar (i.e. horse harness equipment), as was the mode of manufacture (using cire perdue and unleaded metal). However, styles were differentiated: more geometric forms of decoration were employed with the newer materials.
- Methods of manufacture in combination with the materials used, made some castings technically difficult to achieve, emphasising the skill and importance of the smith. The consistent composition of the sealing wax red glass on Late Iron Age objects suggest a small number of sources, implying specialist glass makers and traders. These factors perhaps suggest restrictions on who could trade for specific materials and manufacture certain objects.

Regional similarities and differences

- Within a broad overall set of similarities there were regional differences; this is seen by comparing Seven Sisters and Polden Hill as a western group, Santon as an eastern example and Middlebie from the north.
- The Polden Hill and Seven Sisters hoards show a conservative and restricted use of both object types and materials used. Horse gear predominates; conservatism in style seems to reinforce traditional metal working techniques plus the use of red coloured inlaid glass: other objects from Wales (appendix 8a; 8b) support this interpretation. Where brass is used this closely echos the technological methods used for the manufacture of bronze items.
- The range of materials and objects from the Santon hoard reflect its position in south east England, adjacent to regions with relatively long exposure to trade with continental Gallo-Belgic and Gallo-Roman societies. Such influences can be seen in the deposition of continental brooch types and classical objects, as well as by the larger variation and less strictly observed use of materials for manufacturing Celtic art objects. Where horse gear is included this embraces traditionally decorated quadrilobed strap unions, plus a two link bridle-bit similar to those from Polden Hill. The number of tools included in this hoard expresses the importance of the smith.
- For Middlebie in south west Scotland, the hoard is again predominantly horse gear. It includes many objects exhibiting the distinctive and slightly later northern 'boss style' which shows a less restricted and conservative use of materials, especially concerning the adoption of leaded copper alloys. However, there is also evidence of practice employing more traditional materials and styles commonly used for first century AD Insular La Tène type artefacts, such as simple terrets and the inlaid strap fastener.
- The objects within some of these hoards echo those found with inhumations and cremations, as with Santon. However, in all cases the hoards show a different spatial distribution to known Iron Age burials. It has been pointed out how Santon (and Westhall) fall outside the adjacent areas of pre-Roman cremation burials in south east England (figure 8.65); equally the Polden Hill hoard was deposited away from the Durotrigian cemeteries found further to the south. Iron Age burials are virtually unknown in south east Wales and south west Scotland. Interestingly Stanwick/Melsonby, the only hoard containing offensive weapons, is outside but relatively near to the area of the East Yorkshire burials, where swords and spears are found as grave goods.

Social Organisation

- At the smallest spatial scale it is possible to discern discrete sets of equipment for horses and chariots (and possibly feasting gear), with their own chemical compositions and subtle differences of style. These sets of equipment might have been made for small kinships groups of a few families which differentiated themselves one from another by minor variations of style.
- Analysis starts to allow determination of these small groups, indicating a micro-politics across the country. Affiliated groups could be tied together by sharing resources, exemplified by the production of similarly, but subtly different styled objects; these were probably made during specific episodes of casting, perhaps similar to those at Gussage all Saints. Other ties could include the maintenance of herds of ponies on shared land, from which smaller family units obtained pairs for training and chariot use. Ties might also be maintained through communal feasting and drinking.
- The role of the metalworker was of high importance, and is signified by the presence of tools and weights etc. in many of the hoards. Inclusion in relatively rare episodes of casting for the production of high status metalwork could have imparted further shared links amongst kinship groups. The smith, with access to specific materials such as bronze, brass and glass, or their constituent materials might have served more than one community, but could have been based amongst a particular set of groups where, for the majority of the time, he/she was engaged in producing more mundane artefacts of bronze and iron, and repairing metalwork.
- The high status metalwork used by groups denoted a style and affiliation which was both distinct and recognisable; this could have contributed to the formation or cementation of alliances with other such groups on a wider regional basis, or even perhaps nationally.
- These findings show the subtlety of metallurgical analyses, as distinctions within Iron Age societies are hard to discern through other materials (although perhaps coins might allow this). The metal and glass compositions for the majority of the objects from Polden Hill help to emphasise those artefacts which are both similar and different (e.g. see figures 6.12; 6.13)

Deposition of hoards

- Hoards represented the coming together of a number of small groups with their own sets of objects, where those gathered carried out various forms of destruction and transformation (such as breaking and burning) before depositing things.
- By the time of deposition the original sets of objects had undergone a series of changes; they were often incomplete, as older pieces had become worn or had been broken, and were replaced by new or different pieces originally from other sets. The issue is further complicated by the deposition of incomplete sets for most hoards.
- The 'lives' of objects can be followed to some extent; different wear, patination, and modes of decoration are visible on compositionally similar objects from the same hoards (figures 6.81; 6.94).
- Possibly specific aspects of the ritual deposition of the hoard's content were contributed to by different groups demonstrating distinct participatory roles. This could have included the deposition of foreign 'Roman' material, or personal ornaments. Evidence from Polden Hill suggests that different sets of objects were treated differently at the point of burial; for

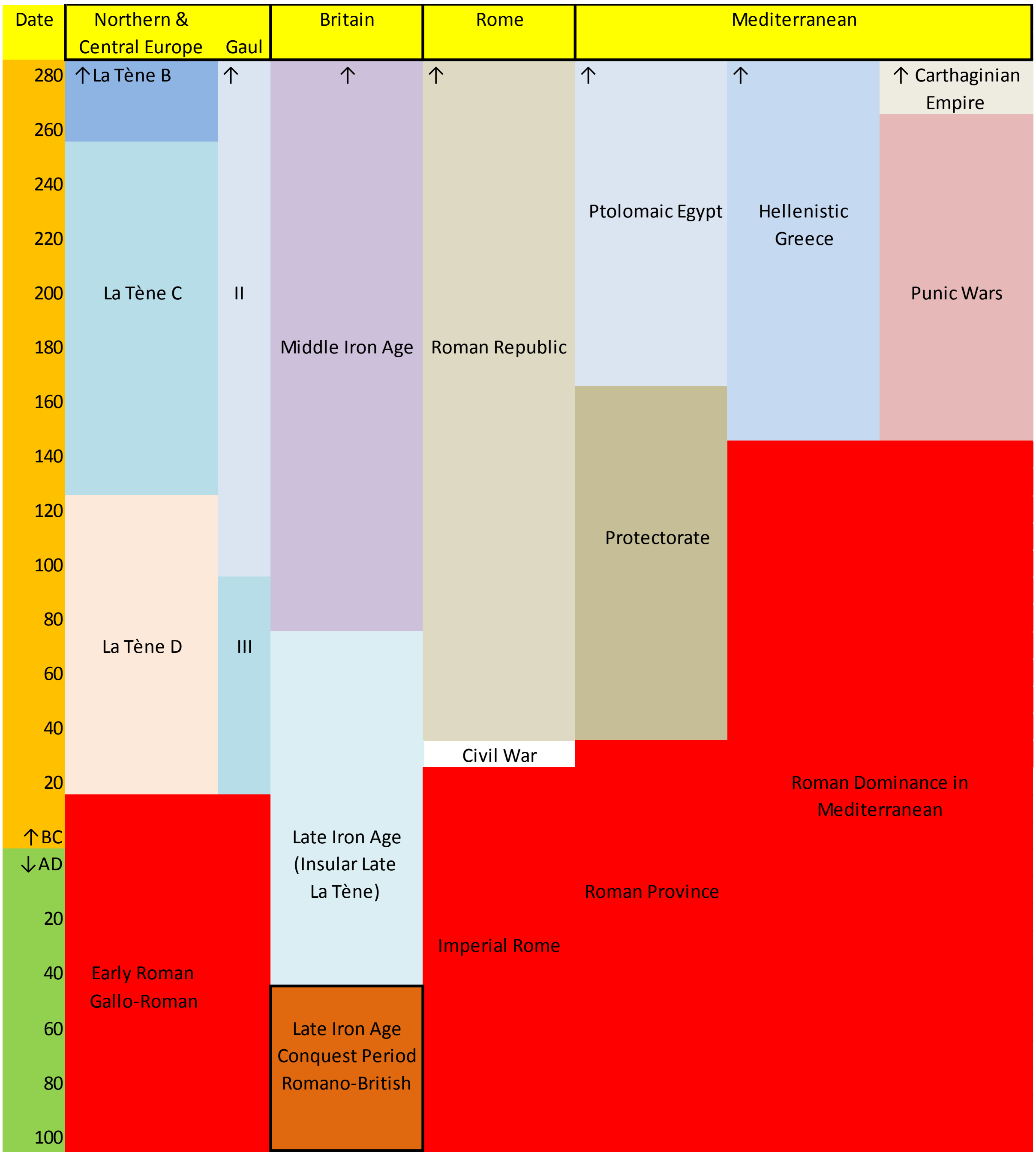
example there is some correlation in the composition of objects which were burnt (figure 6.84; 6.90), or broken (figure 6.82) within the hoard.

Other Object types

- Specially manufactured groups and sets of objects denoting community status and collaboration used specific and tightly controlled compositions, in terms of object type (horse, feasting/drinking) and colour (bronze and red glass; brass and polychrome enamel). They also shared metal compositions in ways that contrasted with fibulae and personal ornaments, which exhibited much more variation. This factor is strongly brought out by Bayley and Butcher's work on fibulae (2004), but also by the brooches seen in the Santon hoard. Although collars and torcs are unusual in these hoards, analysed examples of both the western and northern Late Iron Age collars and torcs also show much less precise compositions, especially as regards the use of leaded copper alloys.

Appendix 1

Dates/cultures/periods referred to in the text



Appendix 2a

Analysis of metal by SEM WDS and SEM EDS

Polden Hill hoard (chapter 6; appendix 4); artefacts from Wales (appendix 8)

Analysis was carried out using a CamScan Maxim 2040 scanning electron microscope (SEM) fitted with an Oxford Instruments wavelength dispersive spectrometer (WDS) and *ISIS* energy dispersive spectrometer (EDS). Operating conditions employed a 30^{o} take-off angle, and a 20kV accelerating voltage. (The *ISIS* spectrometer was changed to an Oxford *INCA* spectrometer during the course of the study).

All minor and trace elements (i.e. all elements except copper) were analysed using WDS; these were mostly chosen to match Northover's suite of elements for similar Iron Age artefacts and usually included: iron, cobalt, copper, zinc, arsenic, tin, antimony, silver, bismuth, lead and gold.

Each element was analysed for 30 seconds (with background counts of fifteen seconds each). The wavelength spectrometer was calibrated using pure element standards, except for lead and arsenic, for which lead telluride and indium arsenide were used.

Oxford Instruments advises that EDS, rather than WDS should be used for major elements (above c.5% weight), and as the optimum set-up for each of the two types of analysis vary, a further set of reading were taken to establish the copper content for all objects, the tin content for bronze, and zinc content for brass. No objects from the Polden Hill hoard or the Iron Age material from Wales contained significant amounts of lead or any other elements. For EDS the samples were analysed for 100 seconds live time with a beam current yielding a count rate of c.4000 counts per second when on a metallic cobalt standard. The energy dispersive spectrometer was calibrated using pure elements, and commercial copper alloy standards were used to evaluate accuracy and precision.

Samples were taken using a 0.9mm drill bit. These were mounted in resin, polished flat and carbon coated.

Each sample was analysed at least three times both by WDS and EDS, and the results were averaged for each sample. Most readings were generally consistent. Acceptable results were in the region of 98.5% to 101.5%; results were then normalised to 100%.

Appendix 2b

Analysis of copper alloys: choosing appropriate standardisation

Ten copper alloy standards were supplied by David Dungworth. Each standard was analysed at 20 kV for 100 live seconds, processor time 5. Initially these readings were standardised against the following elements and compounds (‘A’ Standards – see table A2.1).

Element	**Energy Line**	**A: Standards**	**B: Standards with lead correction**	**C: standards with lead and tin correction**
Aluminium	k	Orthoclase	Orthoclase	Orthoclase
Phosphorus	k	Gallium phosphide	Gallium phosphide	Gallium phosphide
Sulphur	k	Iron pyrites	Iron pyrites	Iron pyrites
Manganese	k	Manganese	Manganese	Manganese
Iron	k	Iron	Iron	Iron
Nickel	k	Nickel	Nickel	Nickel
Copper	k	Bronze 10	Copper	Copper
Zinc	k	Zinc	Zinc	Zinc
Arsenic	k	Indium arsenide	Indium arsenide	Indium arsenide
Tin	l	Bronze 10	Tin	C71.34
Antimony	l	Antimony	Antimony	Antimony
Lead	m	Bronze 10	C50.01	C50.01

Table A2. 1: Elements analysed and the standards used for subsequent quantification of copper alloy standards and objects.

Each copper alloy standard was analysed at three different magnifications: x100; x1000; x10000 and the readings normalised; the results are shown in table A2.2. The following graphs use the accepted values for the standard of a particular element versus x100 analysis of the same element.

	Al	P	S	Mn	Fe	Ni	Cu	Zn	As	Sn	Sb	Pb
33X GM4 (1)	**0.002**	**0.005**	**0.33**	**0.002**	**0.051**	**2.05**	**82.6**	**7.17**	**0.021**	**2.5**	**0.042**	**5.2**
x100	-0.02	-0.05	0.53	0.04	0.08	2.25	83.92	8.21	0.2	2.38	0.02	2.44
x1000	0.03	-0.05	0.89	0	0.1	2.19	83.4	8.74	0	1.94	-0.16	2.93
x10000	0.03	-0.01	0	-0.02	0	2.26	86.63	6.65	0.04	3.92	0.32	0.17
32X PB11 (2)	**0.008**	**0.857**	**0.002**	**0.76**	**0.5**	**1.01**	**90.4**	**1.08**	**0.2**	**3.09**	**0.5**	**1**
x100	0.08	1.43	0	0.84	0.68	1.2	89.73	1.34	0.56	2.87	0.56	0.72
x1000	0.15	0.61	0.04	0.51	0.35	0.75	92.23	1.15	0.66	2.81	0.5	0.24
x10000	0.13	0.53	0.02	0.42	0.19	0.62	92.35	1.3	0.44	3.48	0.8	-0.29
31X B22 (3)	**0.207**	**0.14**	**0.135**	**0.147**	**0.098**	**0.179**	**83.4**	**14.6**	**0.136**	**0.186**	**0.173**	**0.146**
x100	0.3	0.2	0.22	0.33	0.04	0.28	82.67	14.92	0.05	0.22	0.25	0.52
x1000	0.27	0.07	0.3	0.33	0.1	0.26	83.04	15.16	-0.23	0.29	0.29	0.12
x10000	0.35	0.08	-0.02	0.05	0.07	0.19	84.01	15.32	-0.43	0.12	0.18	0.09
B10 (4)	**0.22**	**0.014**	**0.05**	**0.005**	**0.17**	**1.01**	**83.55**	**2.77**	**0.008**	**7**	**1.14**	**4.07**
x100	0.23	0.02	0.06	0.03	0.22	1.01	84.14	2.88	-0.48	6.8	1.26	3.83
x1000	0.25	-0.03	0.11	-0.1	0.21	1.11	83.23	2.82	0.08	7.39	1.52	3.41
x10000	0.16	0.07	-0.01	0.03	0.14	1.32	75.26	1.88	0.25	13.22	3.59	4.09
C30.19 (5)	**5**	**0**	**0**	**0.01**	**0.01**	**0.01**	**67.4**	**26.57**	**0.01**	**1**	**0.01**	**0.01**
x100	4.33	-0.04	0	0.03	-0.02	0.08	67.75	26.84	0.24	0.81	-0.04	0.01
x1000	4.48	0.01	-0.01	-0.06	0	0.09	68.38	26.89	-0.66	0.97	0.02	-0.1
x10000	4.4	-0.05	0.03	-0.02	0.09	-0.01	68.19	26.68	-0.02	0.73	-0.06	0.05
C30.25 (6)	**0**	**0**	**0**	**0.01**	**0.01**	**0.01**	**57.2**	**38.07**	**0.01**	**0**	**0.01**	**4.7**
x100	0.12	0.01	-0.02	0.01	-0.03	0.13	58.08	38.59	-0.3	-0.06	0.06	3.4
x1000	0.08	0.01	0.02	0.01	0.03	0.01	57.12	38.48	0.45	0.15	0.06	3.59
x10000	0.11	-0.04	-0.04	-0.03	0.02	0.04	59.79	38.37	0.31	0.17	0.12	1.19
C50.01 (7)	**0.01**	**0.1**	**0.11**	**0.01**	**0.18**	**1.7**	**75.27**	**0.85**	**0.18**	**9.8**	**0.52**	**11.2**
x100	0.01	0.17	0.14	-0.02	-0.01	2.59	79.46	1.89	-0.65	8.69	0.45	7.27
x1000	-0.03	0.13	0.06	-0.04	0.09	2.68	77.84	1.27	-0.36	9.9	0.4	8.07
x10000	0.04	0.35	-0.04	0.05	-0.02	3.46	76.97	0.97	0.18	10.93	0.34	8.78
C50.03 (8)	**0.001**	**0.12**	**0.11**	**0**	**0.01**	**2.2**	**78.63**	**1.4**	**0.1**	**8.5**	**0.2**	**8.7**
x100	0.04	0.18	0.27	-0.02	0.25	2.04	78.11	1.25	-0.37	10.51	0.7	7.04
x1000	0.03	0.17	0.31	0.04	0.28	2.13	76.2	1.19	0.84	10.54	0.71	7.55
x10000	0.02	-0.03	0	0.02	0.22	2.01	85.82	0.96	0.55	9.49	0.64	0.3
C71.31 (9)	**0.001**	**0.01**	**0.16**	**0.02**	**0.06**	**2**	**83.27**	**4**	**0.06**	**4**	**0.08**	**6.2**
x100	0	-0.02	0.28	0.05	0.14	2.33	85.16	4.02	0.01	4.37	0.16	3.49
x1000	0.01	0.01	0.23	0.01	0.02	2.15	85.92	3.89	-0.21	4.02	0.42	3.54
x10000	0.04	-0.01	-0.04	0.01	0.08	2.04	88.81	3.62	0.43	4.78	0.15	0.09
C71.34 (10)	**0.01**	**0.01**	**0.06**	**0.06**	**0.22**	**0.01**	**87.84**	**1.1**	**0.13**	**7.8**	**0.15**	**2.5**
x100	0.04	0.04	0.11	0.04	0.3	0.09	86.8	1.19	0.51	8.47	0.24	2.18
x1000	-0.01	0.04	0.07	-0.06	0.24	-0.05	89	1.28	-0.65	8.23	0.24	1.64
x10000	0.03	0.02	0.04	0.09	0.28	0	90.29	1.11	0.33	7.12	0.23	0.45

Table A2. 2: The copper alloy standards, their given values for each element and SEM EDS analysis undertaken at variable magnifications (results normalised to 100%)

There was a notable variation in the accuracy of the analysis carried out for different elements. Zinc was the best analysed element with a very high correlation between the analysed and accepted values. The analysed values were approximately 2% relatively too high

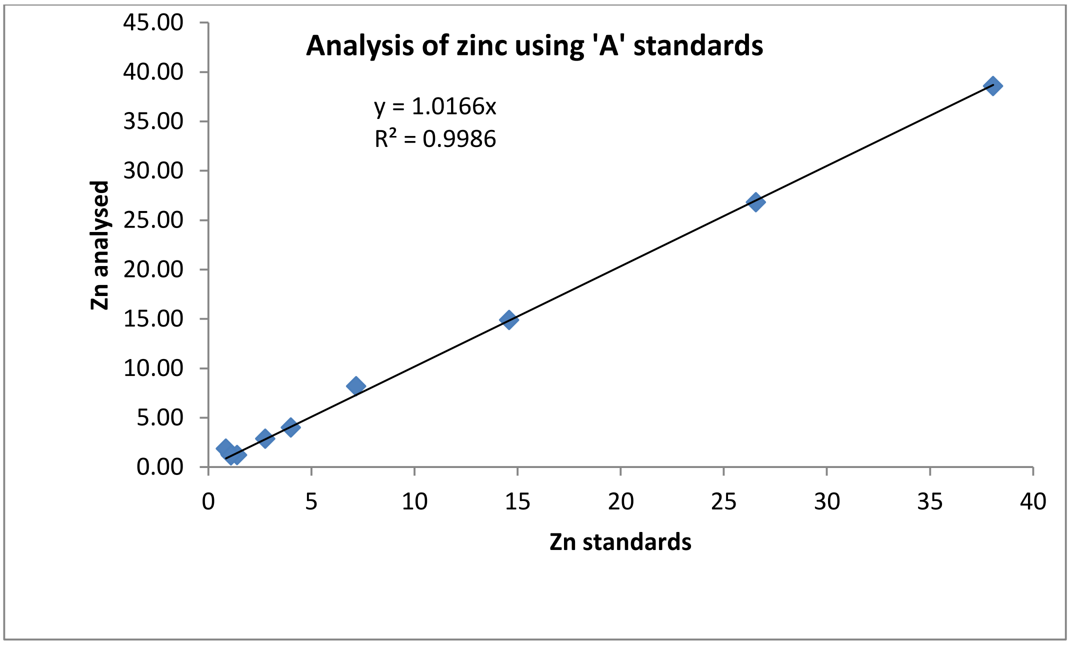


Figure A2. 1: Analysis of zinc at x100 versus the accepted value of the 'A' standards (Table 1)

Lead was the worst analysed element, and the values produced showed a systematic error of 0.6873 of the accepted value of the standard (see figure A2.2 below).

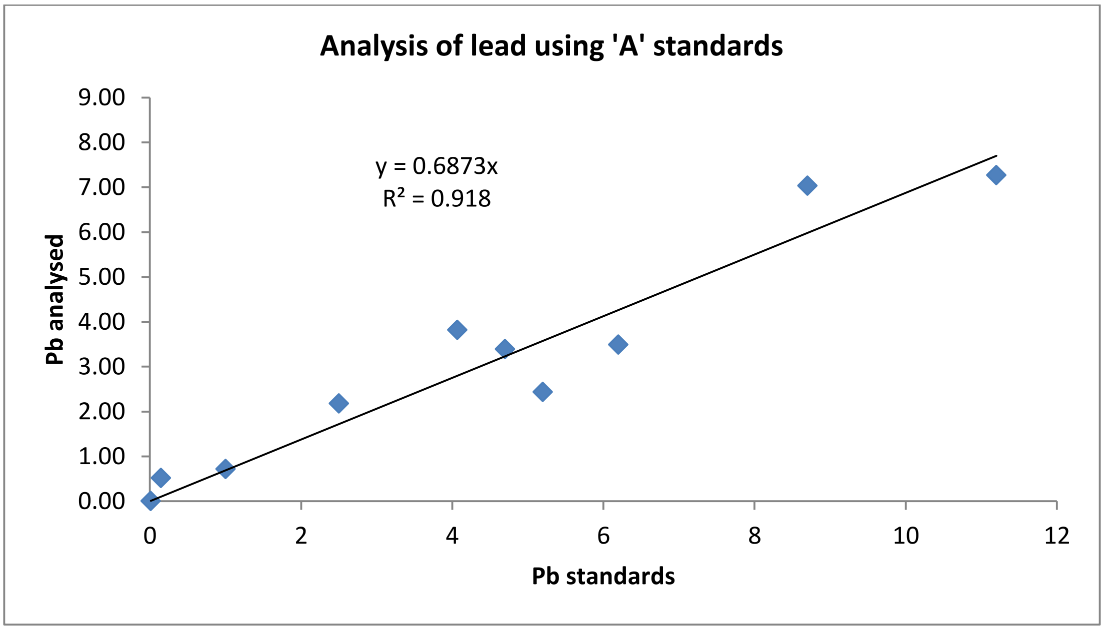


Figure A2. 2: Analysis of lead at x100 using 'A' standards (table 1) showing a systematic error of 0.6873

The values for lead could therefore be corrected by multiplying by 1/0.6873 to bring them nearer to the accepted value (table 3 below).

Pb given	Analysed	Corrected
5.2	2.44	3.55
1	0.72	1.05
0.146	0.52	*0.76*
4.07	3.83	5.57
0.01	0.01	0.01
4.7	3.4	4.94
11.2	7.27	10.58
8.7	7.04	10.24
6.2	3.49	5.08
2.5	2.18	3.17

Table A2. 3: Given, analysed and corrected values for lead within the copper alloy standards.

For SEM EDS analysis there were still errors of up to 1.5% absolute in lead even after the correction has been applied (see corrected values in table A2.3 above).

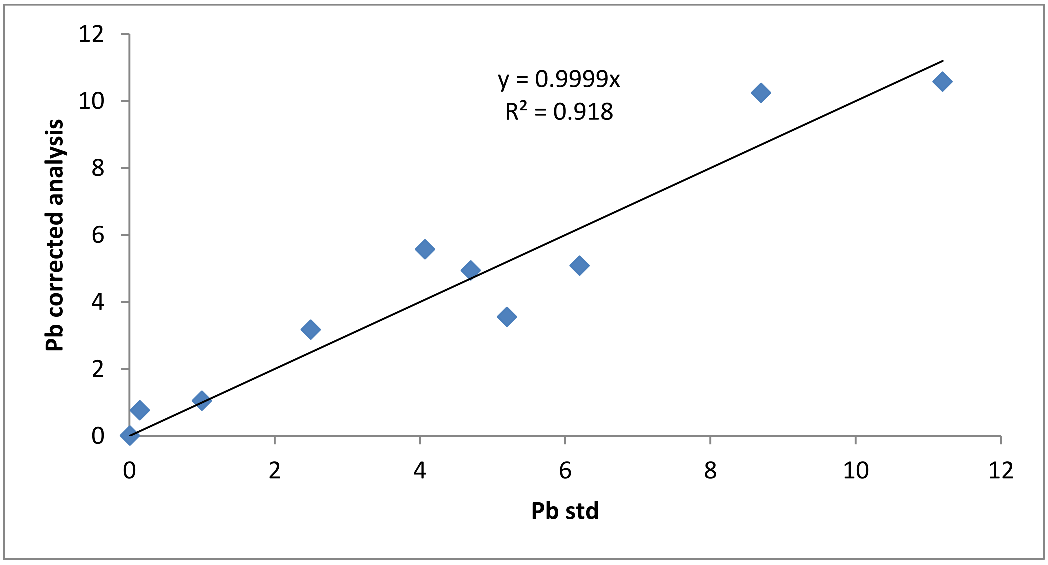


Figure A2. 3: Graph showing lead standards values versus lead analyses with correction applied.

However, there was a further problem illustrated by the scatter around the line which is unlikely to be due to imprecision of the analytical method, but is more likely to be due to segregation of elements/phases within the sample. Inhomogeneous or phased samples can give increased errors with a defocused beam or large scanning area, as the usual correction procedures are calculated on the basis that the sample is homogeneous and therefore that both the electron path and the X-ray path reflect similar compositions. Where there are large grain sizes or phased areas, the electron and X-ray path may occur almost entirely within this (unrepresentative) area, which is different from the bulk of the sample from which the data is being calculated (Albee et al 1977). With the standards analysed here there is an increased possibility of inhomogeneity beyond the analysed areas, because these were not manufactured for microanalysis, but intended for bulk analysis (Freestone pers.com).

Lead in particular causes such problems because of its insolubility within copper/tin/zinc alloys, where it can be seen under magnification as distinct areas within the matrix. Tin and copper alloys also cause problems, especially in cast and slow cooled alloys where discrete phases are large.

In some cases it might be possible to achieve more accurate readings with EDS by analysing a larger area of the sample; table A2.2 shows that in several cases there is a change in the values between x100 and x1000, showing possible inhomogeneity in the areas analysed. However, more consistently accurate analyses for lead in particular can only realistically be achieved by analytical methods using dissolved metal samples, for example ICP.

Another way of increasing the accuracy of the readings without having to apply a separate correction factor would to be standardise the lead against the most accurate lead analysis with the highest value; in this case the standard Pb C50.01. The line within the graph (figure A2. 3) represents the average accuracy of the analyses. By using the highest point nearest to the line as the standard by which to calibrate the values for lead on future samples, there is a smaller degree of error: everything is brought into line with that point, and the future calibration corrects everything to that level. The highest lead level gives the most accurate results as a higher content means there is less inaccuracy on the measurement and therefore random errors will be smaller.

Standards used for the next set of analyses were as for 'A'standards, except that tin and copper were now standardised against pure metal standards, and lead against C50.01 ('B' standards, table A2.1).

This improved the values for the majority of the elements

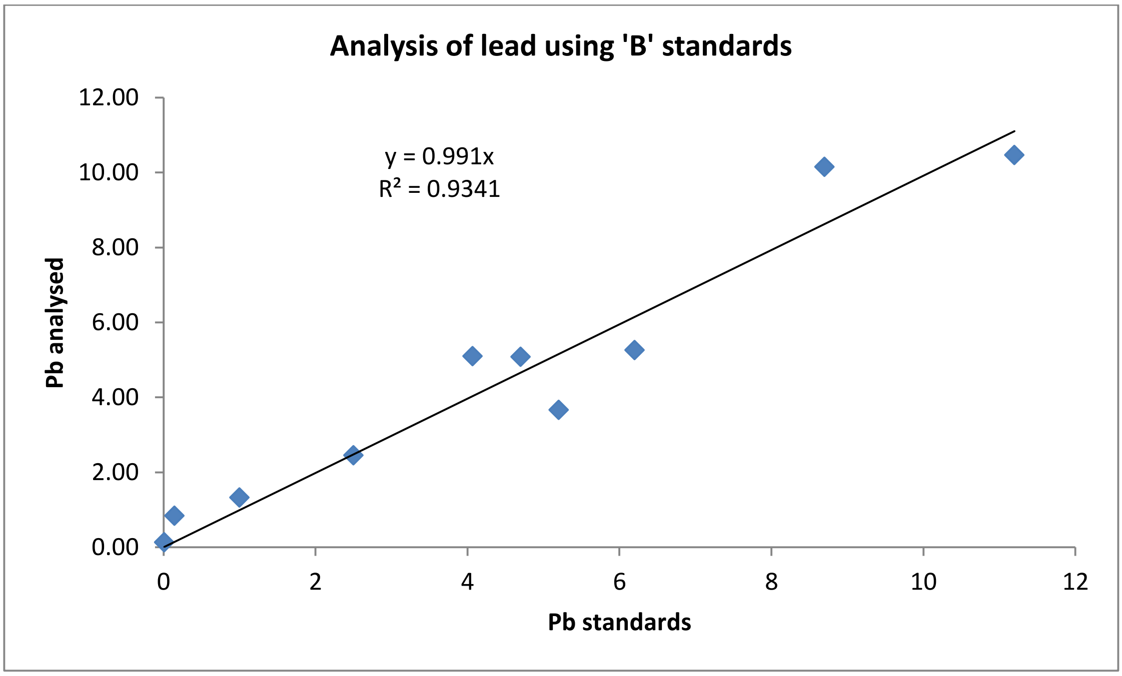


Figure A2. 4: Analysis of lead at x100 using 'B' standards (see table 1).

However tin, the second major element in the majority of objects to be analysed still showed some inconsistency. Analysed values for tin at the higher end of the axes, i.e. with the standards containing the most tin, showed less constancy in relation to the given values. Because the values which were inconsistent with the analysed standards were erratic, such variable readings were probably due to segregation of the tin and copper within the tin/copper phase, (possibly pronounced due to slow cooled casts). In order to acquire more consistent values for tin a further correction was applied; this time by using the standard highest in tin with an analysed value correlating well with the given value of the standard; this was C71.34.

This correction again improved the values for the majority of elements analysed.

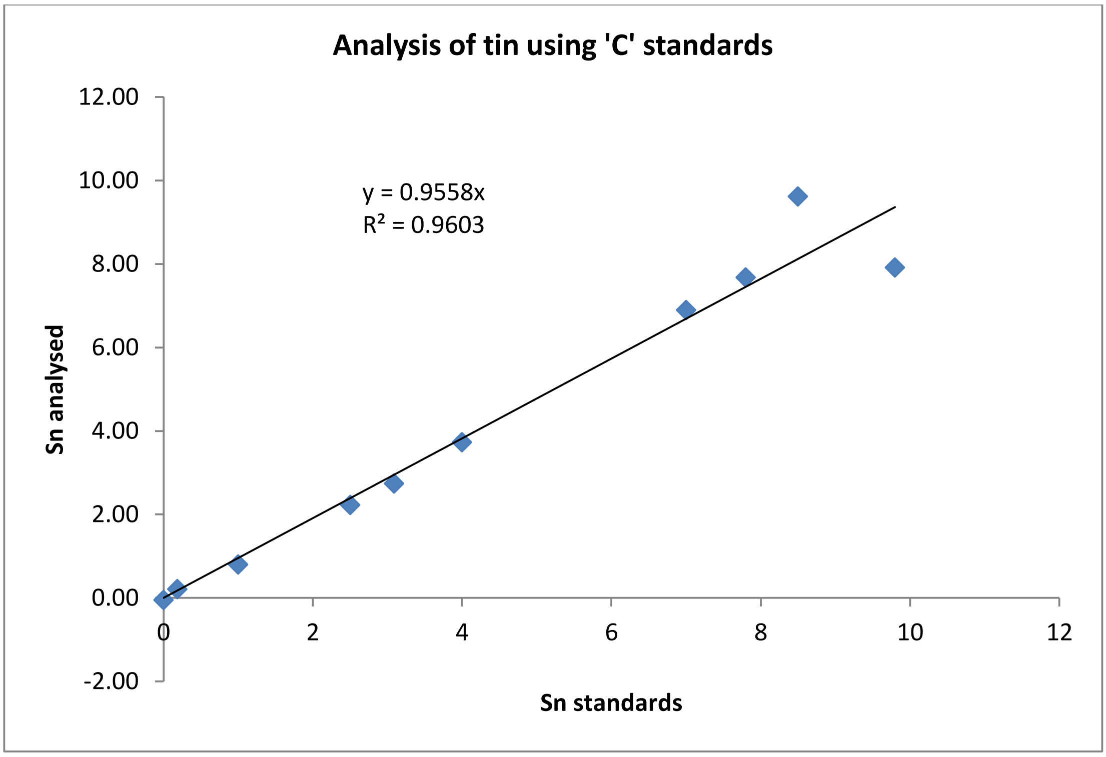


Figure A2. 5: Analysis of tin at x100 using ‘C’ standards (see table 1).

Most of the major elements showed a high rate of accuracy, although there were still some problems with lead, as noted above. However, minor and trace elements still exhibited a large degree of inaccuracy. In order to see if these values coud be improved, the kV used was increased from 20 to 35.

Most of the conditions were maintained for this group of analyses: the same element standards were used (‘C’), and a dead time of approximately 35% maintained. However a new cobalt standardisation was taken before the analyses proceded. Freestone (1996) has shown that the ISIS system can correct data collected at various different accelerating potentials and give reasonable analyses for elements heavier than potassium, and that increasing the kV should improve the detection of minor quantities of heavier elements such as iron and nickel.

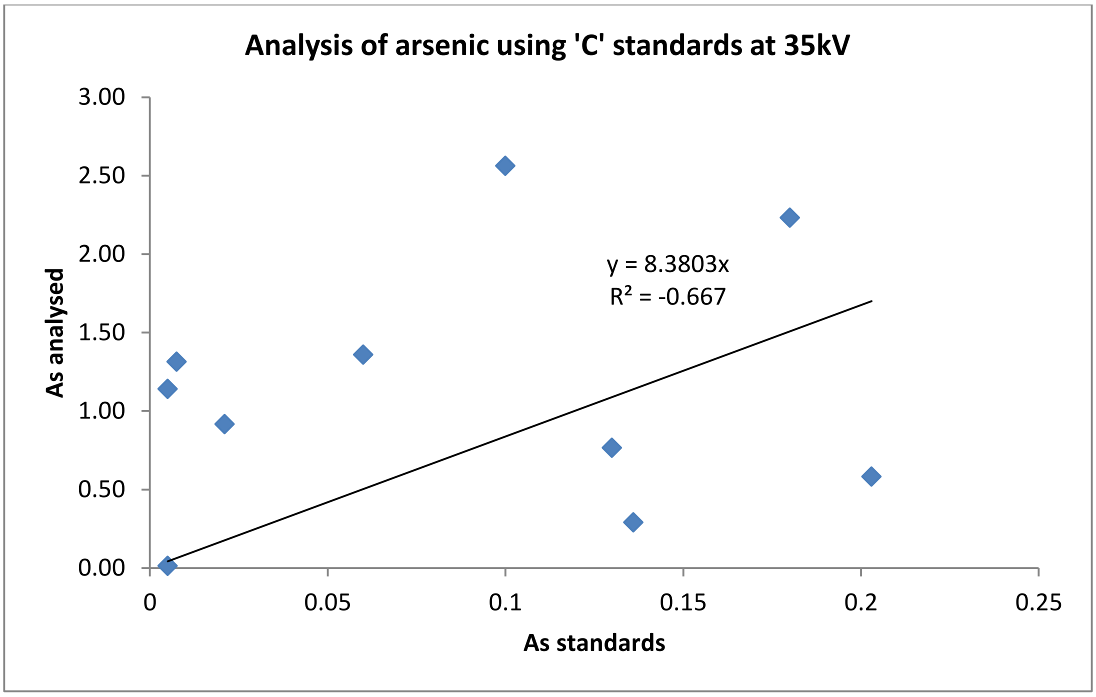


Figure A2. 6: Analysis of Arsenic at x100 at 35kV using ‘C’ standards (see table 1).

Although this gave a slight improvement for some minor elements present, the values, especially for arsenic, were still unacceptable, and levels for the major elements were not as accurate as when analysed at 20kV. It was concluded that minor and trace elements would have to be analysed by wavelength dispersive spectrometry to achieve good results, and that the EDS analysis of major elements would be carried out at 20kV as with initial tests.

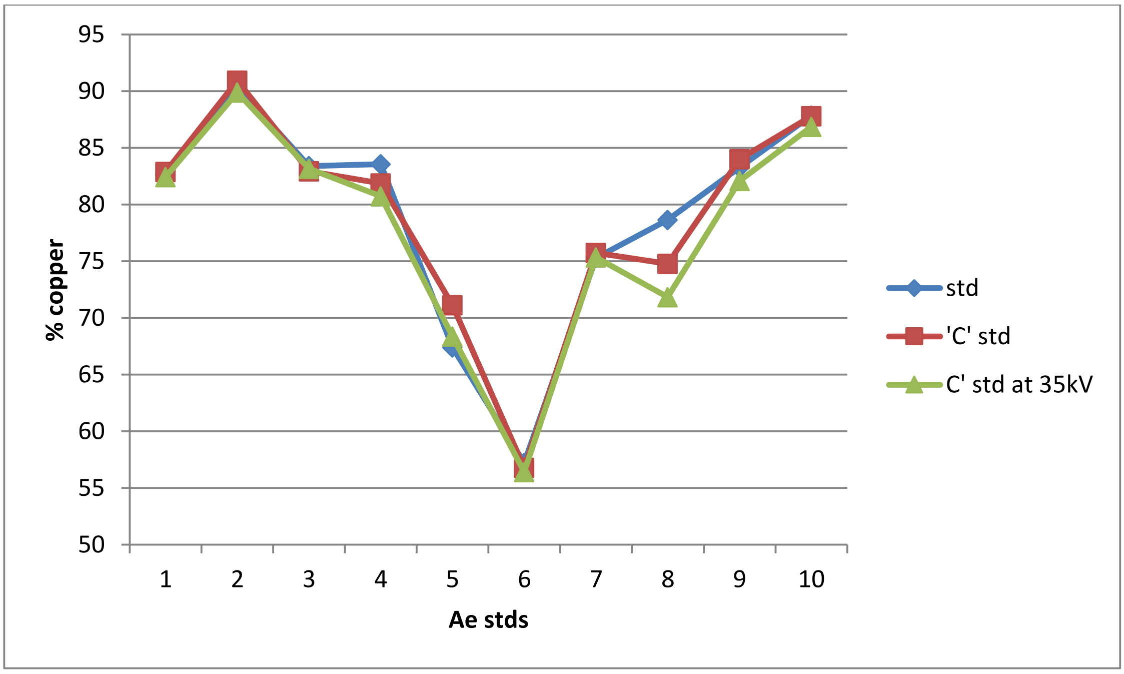


Figure A2. 7: Values for copper in given standards 1-10 (table A2.2), plus corrected analyses for ‘C’ standards (table A2.1) using both 20 kV and 35 kV gave fairly consistent results; standard 8 was the least accurate.

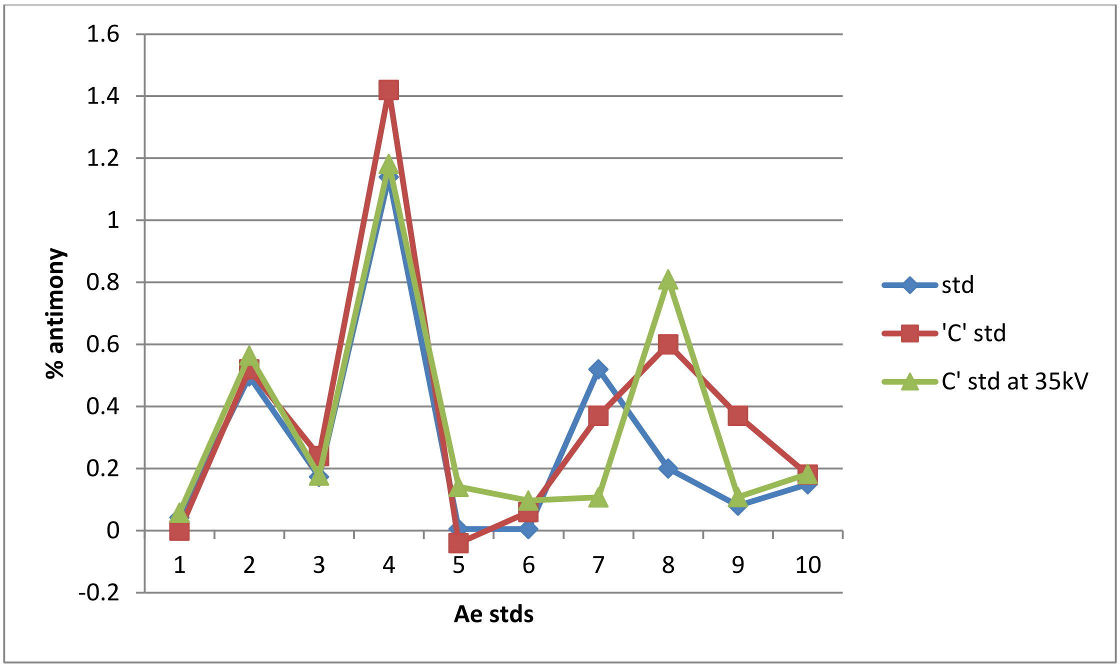


Figure A2. 8: Values for antimony in given standards 1-10 (table A2.2), plus corrected analyses for 'C' standards (table A2.1) using both 20 kV and 35 kV; this gave inaccurate results for standards 7-9 in particular.

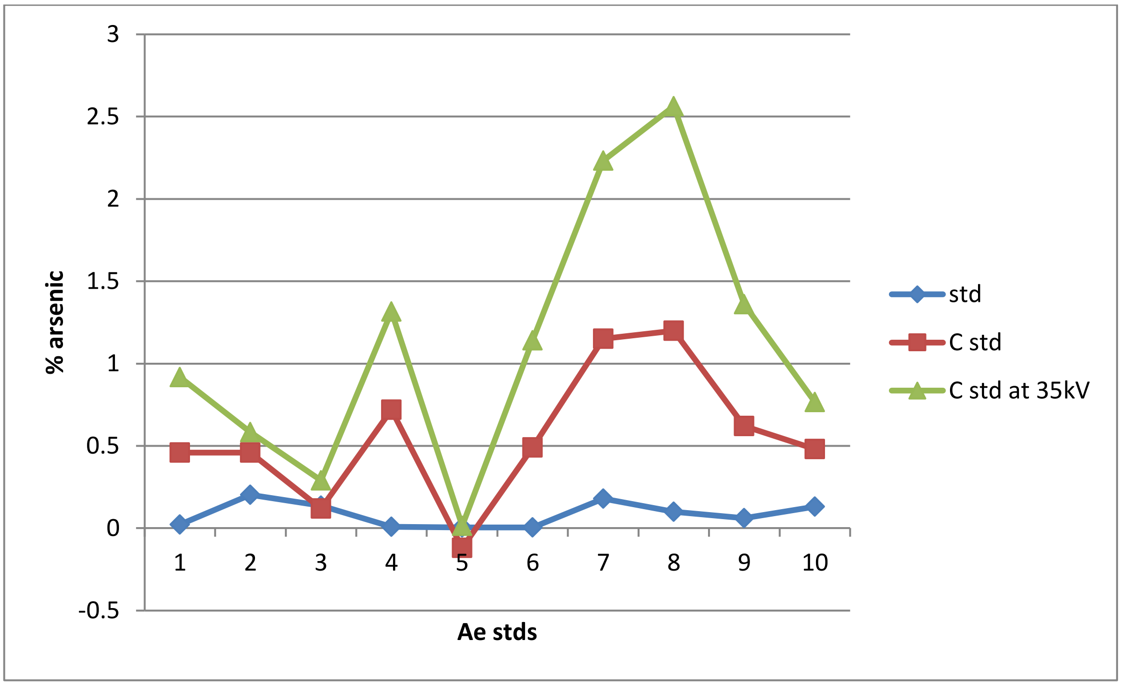


Figure A2. 9: Values for arsenic in given standards 1-10 (table A2.2), plus corrected analyses for 'C' standards (table A2.1) using both 20 kV and 35 kV; this gave inaccurate results for all the standards; 3 and 5 were best.

Results of the analysis of artefact samples using the standards with the lead and tin correction showed good consistency with repeated readings; therefore EDS was used to analyse major elements with applied 'C' standards. WDS was used for minor and trace elements.

Standards used for calibration: Elements and mineral compounds

MAC Micro-analysis Consultants ltd, Unit 3, Edison Road, St Ives Industrial Estate, St Ives, Cambs. PE17 4LF3

3XGM4 (batch W); 32XPB11(batch D); 31XB22 (batch D)
MBH Analytical ltd, Holland House, Queens Road, Barnet, EN5 4DJ

B10
Produced by: Centre Technique des Industries de la Fonderie, 44 Avenue de la Division Leclerc 92318 Sévres Cedex France. Supplied by MBH Analytical ltd, Holland House, Queens Road, Barnet, EN5 4DJ

C.30.19; C30.25; C50.01; C50.03; C71.31; C71.34
BNF Metals Technology Centre, Grove Laboratories, Denchworth Road, Wantage, Oxon, OX12 9BJ

Appendix 2c

Analysis of metal by X-ray Fluorescence at National Museums Scotland

National Museums Scotland: Analytical Research Section. Report No. AR 2012/25
By Lore Troalen.

Middlebie hoard (chapter 9; appendix 7)

The XRF system used was an Oxford Instruments ED 2000 with Oxford Instruments software ED 2000SW version 1.31. The analysed area was irradiated with a primary X-ray beam produced by a Rhodium target X-ray tube. The primary beam was collimated to give an analysed area of about 4 mm × 2 mm. Secondary X-rays were detected with a silicon (lithium) solid state detector. The detection limit varies depending on the elements, matrix and analytical conditions, but is typically in the range of 0.05% - 0.2%. As the analytical technique has a limited penetration depth, the reported compositions may not be representative of the bulk of the alloy if there is a chemically distinct surface layer. Qualitative spectra were collected under the conditions “Old XRF”. This uses an operating voltage of 46 kV and a current of up to 1000 µA (set automatically for a 45% dead time) without a primary beam filter to ensure detection of all elements of atomic number 19 or above of interest in copper and lead alloys.

Semi-quantitative analyses were collected using “Copper Alloy 2008” method with the following settings: 150 sec: 35 kV, 1000 mA, thin Rhodium filter and then 300 sec: 50 kV, 1000 mA, thick copper filter. The analytical system was calibrated using BF 10 and GM8 B copper alloys standards

The objects were investigated without surface cleaning. In the case of a few complex artefacts, the different constituting parts were investigated X-ray fluorescence (XRF). No surface preparation or cleaning was undertaken; therefore the results presented below should be taken as semi-quantitative analysis only.

Appendix 2d

Analysis of metal by X-ray Fluorescence (hand held XRF)

Santon hoard (chapter 8; appendix 6)

Analysis of the objects from the Santon hoard was carried out at the Cambridge University Museum of Archaeology and Anthropology using a Bruker AXS Tracer III-SD portable XRF with a rhodium tube and silicon drift detector (SDD); with a 10 × 8 mm elliptical spot size.

Where possible, a flat cleaned surface of each metal object was positioned directly on the detector window to obtain as consistent results as possible. All analyses were undertaken in a Bruker bench-top stand for health and safety reasons and for ease of positioning the objects. Each analysis was undertaken using 40kV and 9.6 µA with a 25 µm titanium/300 µm aluminium filter, and run for 100 seconds live time. Data were processed using S1CalProcess v.2.2.32 with empirical calibrations to produce weight % elemental compositions. Empirical calibrations were calculated from metal standards and supplied by Mike Dobby (Bruker). Most objects were analysed three times and an average taken. Some objects were analysed on both surfaces, especially where tinning was present (appendix 6b).

Spectra were also assessed visually; sometimes high lead contents and the presence of corrosion products distorted the readings, but the spectra were still able to supply basic qualitative information for the metal alloy, e.g. leaded bronze with traces of arsenic. All results must be viewed as semi-quantitative at best, but readings were generally very consistent for objects where corrosion products had been almost entirely removed (see appendix 6a).

Appendix 2e

Analysis of glass and enamel by SEM EDS

Polden Hill (chapter 6, appendix 4); Seven Sisters (chapter 7, appendix 5) artefacts from Wales (appendix 8).

The glass was analysed using a CamScan Maxim 2040 scanning electron microscope (SEM) fitted with an Oxford Instruments energy dispersive X-ray detector and ISIS (later INCA) spectrometer. Operating conditions employed a 30^{o} take-off angle, a 20kV accelerating voltage, and the samples were detected for 100 live seconds using a count rate of c.4000 counts per second when on a metallic cobalt standard.

The spectrometer was calibrated using pure elements, oxides and minerals; Sheffield glass standards were also used to improve the silica to lead oxide ratio in highly leaded glass. Corning and Sheffield glass standards were used to assess further the accuracy and precision of the analysis.

Each sample was analysed at least three times both by, and the results were averaged for each sample. Most readings were generally consistent. Acceptable results were in the region of 98.5% to 101.5%; results were then normalised to 100%.

Sampling and Mounting

The glass was sampled in the conventional way: approximately $1mm^2$ pieces were removed and embedded in polyester resin which was then polished down using silicon carbide and alumina polishing agents.

Some fragments of glass and enamel were mounted on slides using epoxy resin and polished down to a thickness of 30 µm to allow analysis by transmitted light in a polarising light microscope.

Appendix 3

Sources for the analyses of glass used in the thesis

Early Near East and Egyptian red glass: Freestone, 1987; Brill & Cahill, 1988.

Middle Iron Age red glass: Henderson 1991; Freestone and Henderson unpublished.

Middle Iron Age white, clear, yellow glass: Henderson 1981; 1987; 1995

La Tène B, C and D red glass: Brun 1991; Brun and Pernot 1992

Late Iron Age yellow glass: Henderson Warren 1982; Davis and Freestone forthcoming; Davis forthcoming.

Late Iron Age red glass: Freestone et al 2003; Freestone pers. comm.; Davis appendix 4, 5 and 8

Jerusalem glass: Freestone pers. comm.

Jalame glass: Brill 1988

Roman mosaic vessel glass: Freestone and Stapleton 2015

Roman yellow tesserae and mosaic glass: Mass *et al.* 1998

Roman sealing wax red glass: Daniele *et al.* 1999 Arletti *et al.* 2006; Boschetti 2011;

Romano-British sealing wax red glass: Bayley 2001; 2005; Freestone *et al.* 2003; Davis appendix 8.

Romano-British glass: Henderson 1981; 1989; 1991; Bateson and Hedges 1975

British vessel glass: Jackson 2005; Paynter 2006; Mirti *et al.* 1993; Heyworth *et al.* 1990

Appendix 4a

Polden Hill catalogue

Accession no.	Object	Material	Brailsford	Palk no.	length (cm)	diameter (cm)	weight (g)	
46.3-22.64	bridle bit	impure bronze	bridle-bit 11	SJ 13	8	7	286.3	
46.3-22.65	bridle bit	bronze	bridle-bit 5	SJ 10	9.2	7.5	368.4	
46.3-22.66	bridle bit	bronze	bridle-bit 14	SJ 7	7.3	7	374.4	
46.3-22.67	bridle bit	bronze	bridle-bit 13	SJ 8	7.1	7.1	375.3	
46.3-22.68	bridle bit	bronze	bridle-bit 9	SJ 11	7.8	7.2	334.7	
46.3-22.69	bridle bit	bronze	bridle-bit 10	SJ 12	8	7.2	335.9	
46.3-22.70	bridle bit	bronze	bridle-bit 13	SJ 17	7.9	6.8	320.1	
46.3-22.71	bridle bit	bronze	bridle-bit 6	SJ 9	9.2	7.6	450	
46.3-22.72	bridle bit	bronze	bridle-bit 7	SJ 15	7.9	6.7	328.8	
46.3-22.73	bridle bit	bronze	bridle-bit 12	SJ14	8.1	7	280.7	

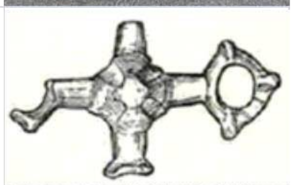
46.3-22.74	bridle bit	bronze	bridle-bit 18	SJ 16	8	6.8	323.5	
46.3-22.75	bridle bit	bronze	bridle-bit 15	SJ 21	7.7	8	301.5	
46.3-22.76	bridle bit	bronze	bridle-bit 4	SJ 18		6.8	372.6	
46.3-22.77	bridle bit	bronze	bridle-bit 2	SJ 20		8.5	173.8	
46.3-22.78-80	bridlebit	bronze	bridle-bit 1	SJ 19	11.1	8.4; 8.8		
46.3-22.81	bridle bit	bronze	bridle-bit 4?				83.1	
E.1785	bridle bit	*copper alloy*	E.1785	SJ 22	8.8			
46.3-22.82	terret	bronze	terret 1b		5.7		55	
46.3-22.83	terret	bronze	terret 1a		5.7		57	
46.3-22.84	terret	bronze	terret 1e		4.8		50.6	

46.3-22.85	terret	bronze	terret 1c		5.5		58.4	
46.3-22.86	terret	bronze	terret 1f		4.8		52.2	
46.3-22.87	terret	bronze	terret 1d		4.8		50.1	
46.3-22.88	terret	bronze	terret 2b		7.3		95.2	
46.3-22.89	terret	bronze	terret 2c		7.3		107.8	
46.3-22.90	terret	bronze	terret 2a		7.1		**93.6**	
46.3-22.91	terret	bronze	terret 2d		7.1		95.1	
46.3-22.92	terret	bronze	terret 3a		9.5		108.9	

46.3-22.93	terret	bronze	terret 2m		8.2		123.9	
46.3-22.94	terret	bronze	terret 2h		9.5		283.4	
46.3-22.95	terret	bronze	terret 2i		10.8		309.7	
46.3-22.96	terret	bronze	terret 2j		9.5			
46.3-22.97	terret	bronze	terret 2k		10.8		299.9	
46.3-22.98	terret	bronze	terret 2l		8			
46.3-22.99	terret	bronze	terret 2n		8.3		246.5	
46.3-22.100	terret	bronze	terret 3b		8		176.6	

46.3-22.101	terret	bronze	terret 2e		7.3		112.7	
46.3-22.102	terret	bronze	terret 2f		7.3		99.9	
46.3-22.103	terret	bronze	terret 2g		7.3		119.1	
46.3-22.104	terret	bronze	terret 2o		7.3			
46.3-22.105	head harness	*copper alloy*	misc 14		c.13		17.8	
46.3-22.106	ring	brass	misc 8		5.62		48.6	
46.3-22.107	pendand hook	bronze	misc 3		9.5		89.6	
46.3-22.108	pendand hook	bronze	misc 3b		9.5		85.3	
46.3-22.109	cuirass hook	brass	dolphin 1		9.1		25.7	
46.3-22.110	cuirass hook	brass	dolphin 2		9.5		30.8	

46.3-22.111	cuirass hook	brass	dolphin 3		9.5		29.6	
46.3-22.112/113	horse brooch	bronze	horse trapping 1		17x12.3		207.7	
46.3-22.114	shield boss	bronze	shield boss 1		21.5			
46.3-22.115	shield boss	bronze	shield boss 2		21			
46.3-22.116	shield boss	*copper alloy*	shield boss 3		21			
46.3-22.117/118	torc	iron and brass	misc 2		17.2		189.9	
46.3-22.119	brooch	*copper alloy*	brooch 4		2.74		4.2	
46.3-22.120	brooch	bronze	brooch 1		8.6		37.6	

46.3-22.121	brooch	*copper alloy*	brooch 5		2.74		4.6	
46.3-22.122	brooch	*copper alloy*	brooch 6		2.54		2.8	
46.3-22.123	chape	bronze	misc 1		6.4x3.8		23.6	
46.3-22.124	ring	impure bronze	misc 12		2		9.2	
46.3-22.125	brooch	brass	brooch 2		7		8.5	
46.3-22.126	bridle spur	*copper alloy*	misc 6		5.4			
46.3-22.127	brooch	brass	brooch 3		2.74		5.7	
46.3-22.128	medical instrument	*copper alloy*	misc 13		c.15			
46.3-22.129	nave band	bronze	misc 11a		9.5x 5.5x1.5		41.1	
46.3-22.130	nave band	bronze	misc 11b		12x 5.5x1.5		46.7	
46.3-22.131	nave band	bronze	misc 11c		19.8x 5.5x1.5		76.8	
46.3-22.132	decorated strip	bronze	misc 10		5.1		11	

46.3-22.142	toggle	bronze	toggle 5		10.46			
46.3-22.143	toggle	bronze	toggle 6		11.3			
46.3-22.144	terret	bronze	terret 1g				20.09	
46.3-22.145	ring	iron	misc 7		5.1			
46.3-22.146	lynch pin?	iron	misc 4		10.5			
46.3-22.147	bracelet	bronze	bracelet 1		9		92.4	
46.3-22.148	bracelet	bronze	bracelet 2		9		67.1	
89.7-6.77	strap union	bronze	horse trapping 4		9.7x8.8		189	
89.7-6.78	horse brooch	bronze	horse trapping 2		14.8		260.8	
89.7-6.79	horse brooch	bronze	horse trapping 3		9.35x5.5		54.1	

Appendix 4b

Polden Hill hoard: metal data normalised to 100% (SEM with EDS/WDS) [3]

Object	Object no.	Fe	Co	Ni	Cu	Zn	As	Ag	Sn	Sb	Au	Pb
bridle-bit	PH 46.64a	0.1	0	0	84.2	4.3	0.4	0.3	11.8	0	0	0
bridle-bit	PH 46.64b	0	0	0	87.3	0.3	0.3	0.1	13.1	0	0	0.1
bridle-bit	PH 46.64c	0	0	0	86.4	0.3	0.3	0.1	13.9	0	0	0.5
bridle-bit	PH 46.64d	0.1	0	0.1	87.7	0.5	0.4	0.1	11.8	0	0.1	0.3
bridle-bit	PH 46.65a	0.1	0	0	88.3	0.1	0.3	0	12.3	0	0	0
bridle-bit	PH 46.65a	0.1	0	0	86.3	0	0.3	0.1	13.2	0	n/a	0
bridle-bit	PH 46.65b	0.3	0	0	87.8	0.1	0.2	0.1	12.6	0	0	0
bridle-bit	PH 46.65b	0	0	0	85.5	0.1	0.3	0.1	13.8	0	n/a	0.1
bridle-bit	PH 46.66A	0.4	0	0.1	87.3	0.4	0.3	0.1	11.7	0	0	0.3
bridle-bit	PH 46.66B	0.1	0	0	87.5	0.1	0.4	0	12.5	0	0	0.1
bridle-bit	PH 46.66C	0.5	0	0	87.8	0.1	0.2	0	12.1	0	0	0
bridle-bit	PH 46.67a	0.1	0	0.1	85.4	0.1	0.3	0.1	14.6	0	0.1	0.3
bridle-bit	PH 46.67b	0.1	0	0.1	87.9	0.1	0.4	0.1	12.5	0	0	0
bridle-bit	PH 46.67c	0.8	0	0	87.2	0.5	0.2	0.1	12.1	0	0	0
bridle-bit	PH 46.68a	0.1	0	0	87.3	0.1	0.3	0	12.2	0	0	0
bridle-bit	PH 46.68b	0.3	0	0	86.9	0.1	0.2	0.1	12.4	0	0	0
bridle-bit	PH 46.68c	0.4	0	0	87.2	0.1	0.2	0	12	0	0	0
bridle-bit	PH 46.69a	0	0	0	86.8	0	0.2	0.1	13.8	0	0	0
bridle-bit	PH 46.69b	0.1	0	0	86.9	0	0.2	0.1	13.6	0	0.1	0
bridle-bit	PH 46.69c	0.1	0	0	86.7	0.1	0.3	0.1	13.6	0	0	0.1
bridle-bit	PH 46.70a	0.1	0	0	88.3	0.3	0.4	0.1	11.6	0	0	0.1
bridle-bit	PH 46.70b	0	0	0	89.6	0.1	0.5	0	10	0	0.2	0.4
bridle-bit	PH 46.71a	0.1	0	0	88.4	0.1	0.4	0.2	11.4	0	0	0.3
bridle-bit	PH 46.71b	0.1	0	0	88.7	0.1	0.5	0.2	10.9	0	0.1	0.3
bridle-bit	PH 46.71c	0.3	0	0	86.7	0.2	0.5	0.1	12.9	0	0	0.3
bridle-bit	PH 46.72a	0	0	0	89.2	0.4	0.2	0.1	11	0	0	0.1
bridle-bit	PH 46.72b	0	0	0	87.6	0.3	0.2	0.3	12.3	0.2	0.1	0.1
bridle-bit	PH 46.73a	0	0	0	88.7	0.5	0.4	0.1	10.9	0	0	0.2
bridle-bit	PH 46.73b	0.1	0	0	86.7	0.4	0.4	0.1	13.1	0	0.1	0.2
bridle-bit	PH 46.73c	0	0	0.1	87	0.2	0.4	0.1	12.9	0	0.1	0.2
bridle-bit	PH 46.74a	0	0	0	88	0.1	0.5	0.2	11.1	0.5	0	0.4
bridle-bit	PH 46.74b	0	0	0	89.6	0.1	0.3	0.3	10.1	0	0.1	0.2
bridle-bit	PH 46.75a	0.1	0	0.1	88.3	0.1	0.5	0.1	11.1	0	0	0.8
bridle-bit	PH 46.75a	0.1	0	0.1	88.3	0.1	0.5	0.1	11.1	0	0	0.8
bridle-bit	PH 46.75b	0.1	0	0.1	89.6	0.1	0.2	0.1	10.6	0	0	0.1
bridle-bit	PH 46.75c	0.1	0	0.1	89.6	0	0.3	0.1	10.5	0	0	0.1
bridle-bit	PH 46.75d	0.2	0	0	89.4	0.1	0.3	0.1	10.7	0	0	0
bridle-bit	PH 46.76a	0	0	0.1	88.1	0.1	0.3	0	12.1	0	n/a	0.2
bridle-bit	PH 46.76b	0.1	0	0.1	88.6	0.3	0.5	0.1	10.2	0.1	0	0.9
bridle-bit	PH 46.76c	0	0	0.1	91	0.2	0.3	0.1	8.7	0	0.1	0.2
bridle-bit	PH 46.77a	0	0	0	91.7	0.1	0.7	0	7.2	0.2	0.1	0

[3] Black text = SEM WDS; red text = SEM EDS

bridle-bit	PH 46.77b	0	0	0	89.9	0	0.7	0	9.1	0.3	0.1	0.5
bridle-bit	PH 46.78a	0	0	0	91.3	0	0.7	0.1	7.6	0.2	n/a	0.1
bridle-bit	PH 46.79-80	0	0	0	91.2	0.1	0.7	0.1	7.9	0	n/a	0.1
bridle-bit	PH 46.79-80	0	0	0	88.7	0	0.5	0	10.7	0	n/a	0
bridle-bit	PH 46.79-80	0	0	0	86.8	0	0.4	0	12.6	0	n/a	0
bridle-bit	PH 46.81	0	0	0	89.1	0	0.3	0.1	11.2	0	0	0
terret	PH 46.82	0.2	0	0.1	89.6	0.3	0.2	0.1	10	0	0.1	0
terret	PH 46.83	0.3	0	0	89.9	1.2	0.3	0	9	0	0	0.1
terret	PH 46.84	0	0	0	86.3	0	0.2	0.1	14.8	0	0	0
terret	PH 46.85	0.1	0	0	88.7	0.1	0.2	0.1	11.5	0	0.1	0
terret	PH 46.86	0.1	0	0	88.8	0.1	0.3	0.1	11.4	0	0	0
terret	PH 46.87	0	0	0	89.5	0.1	0.2	0	11.2	0	0.1	0
terret	PH 46.88	0	0	0	85.3	0.1	0.3	0	14.3	0	0	0
terret	PH 46.89	0.1	0	0	89.5	0.2	0.3	0.1	10.6	0	0	0.1
terret	PH 46.90	0	0	0	90	0	0.5	0.1	9.7	0	0	0.2
terret	PH 46.91	0	0	0	88.9	0.1	0.3	0	11.4	0	0	0
terret	PH 46.92	0	0	0	87.7	0.1	0.3	0.1	12.1	0.1	0	0.1
terret	PH 46.93	0	0	0	88.2	0.1	0.2	0.2	11.9	0	0.3	0.1
terret	PH 46.94	0.2	0	0.1	88.3	0	0.3	0.1	11.7	0	0.2	0
terret	PH 46.95	0.1	0	0	88.1	0.1	0.3	0.1	11.7	0	0	0.1
terret	PH 46.96	0	0	0	87.2	0.1	0.3	0.1	12.3	0	n/a	0
terret	PH 46.97	0	0	0.1	88.9	0.1	0.4	0.9	10.2	0	0.1	0.1
terret	PH 46.98	0.6	0	0	86.6	0.4	0.3	0.1	11.8	0	n/a	0.1
terret	PH 46.99	0	0	0	89.6	0	0	0	10.3	0	0.1	0
terret	PH 46.100	0	0	0	90.2	0	0	0	9.6	0.2	0.1	0
terret	PH 46.101	0	0	0	90.6	0	0	0	9.3	0	0.2	0
terret	PH 46.102	0.1	0	0	88.7	0.1	0.3	0.1	11.1	0	0	0
terret	PH 46.103	0	0	0	89.9	0	0.1	0	10.3	0	0.1	0
terret	PH 46.104	0	0	0	88.7	0	0.1	0.1	11	0	n/a	0
terret	PH 46.105	0	0	0	88.7	0	0.1	0.1	11	0	n/a	0
knobbed ring	PH 46.106	0.8	0	0.3	81.7	15.4	0.6	0.1	1.1	0	0	0.4
trace hook	PH 46.107	0	0	0	87.4	0	0.3	0	13.1	0	0	0.1
trace hook	PH 46.108	0	0	0	89.3	0	0.1	0	10.9	0	0.1	0
dolphin hook	PH 46.109	0	0	0	77.3	22.5	0.1	0	0.5	0	0	0
dolphin hook	PH 46.110	0.1	0	0	78.2	22	0.1	0	0.2	0	0	0
dolphin hook	PH 46.111	0.1	0	0	78.5	21.6	0.2	0.1	0.1	0	0	0
horse brooch	PH 46.112	0	0	0	86	0	0.2	0	14.3	0	0.1	0
horse brooch	PH 46.113	0	0	0	87.9	0	0.1	0	12.3	0.2	0.2	0
shield boss	PH 46.115	0	0	0	88.6	0.1	0.7	0	11.1	0	0	0.5
shield boss	PH 46.116	0	0	0	88.8	0.1	0.1	0	12	0	0	0
torc	PH 46.118	0.1	0	0	75.7	24	0.2	0.1	0.3	0	0	0
brooch	PH 46.120	0.1	0	0	88.5	0.8	0.4	0.1	11.1	0	0	0.2
chape	PH 46.123	0.2	0	0	88	0.1	0.5	0.1	11.5	0	0	0.7
ring/ferrule	PH 46.124	0.2	0	0	95.4	1.5	0.4	0	3.2	0	0	0.1
brooch	PH 46.125	0.1	0	0	82.6	15.9	0.3	0	1.7	0.1	0	0.1
brooch	PH 46.127	0	0	0	78.8	21.6	0.2	0	0	0	0	0
nave hoop	PH 46.129	0	0	0	88.3	0	0.2	0.1	11.7	0.1	0	0.1

nave hoop	PH 46.130	0	0	0	87.7	0	0.2	0	12	0.1	0	0
nave hoop	PH 46.131	0	0	0	88.1	0	0.3	0.1	11.7	0	0	0.1
dec object	PH 46.132	0	0	0	89.1	0.1	0.2	0.1	11.1	0	0	0
hammer	PH 46.133	0.1	0	0.1	85.5	0.1	0.2	0.5	14.2	0	0	0
toggle	PH 46.136	0	0	0	88.7	0	0.1	0	11.5	0	0.3	0
toggle	PH 46.137	0.1	0	0	87.5	0.4	0.3	0.1	11.9	0.1	0	0
toggle	PH 46.139	0	0	0	89.5	0.1	0.3	0	11.3	0	0	0
toggle	PH 46.142	0	0	0	87.6	0	0.2	0	12.2	0	n/a	0
toggle	PH 46.143	0.1	0	0	87.5	0.2	0.2	0.1	12	0	n/a	0.1
terret	PH 46.144	0.1	0	0	86.1	0.1	0.3	0.1	14.3	0	0	0
bracelet	PH 46.147	0.1	0	0	87.6	0.2	0.4	0	12	0.1	0	0.1
bracelet	PH 46.148	0.1	0	0	89.3	0	0.1	0.1	10.9	0	0.1	0
strap union	PH 89.77	0	0	0	88.3	0	0	0	11.8	0	0	0
horse brooch	PH 89.78	0	0	0	87.4	0	0.1	0	12.4	0	0.1	0.1
horse brooch	PH 89.79	0	0	0	87.9	0	0.1	0	12.1	0	0	0

Appendix 4c

Polden Hill hoard: glass data normalised to 100% (SEM with EDS)

Object r	Object	Na2O	MgO	Al2O3	SiO2	P2O5	Cl	K2O	CaO	TiO2	MnO	Fe2O3	CuO	ZnO	SnO2	Sb2O3	PbO
65A	bridle-bit	10.12	0.45	2.54	41.10	0.38	0.59	0.55	4.93	0.07	0.32	0.44	10.64	0.03	0.00	1.06	26.77
69A	bridle-bit	11.06	0.44	1.88	40.07	0.40	0.72	0.50	4.15	0.04	0.26	0.45	10.19	0.01	0.04	1.38	28.39
69B	bridle-bit	10.57	0.42	1.57	39.92	0.37	0.65	0.54	4.29	0.05	0.32	0.36	8.36	0.00	0.00	1.49	31.07
70	bridle-bit	11.19	0.48	2.07	41.69	0.40	0.78	0.47	4.32	0.13	0.07	0.62	6.04	0.01	0.00	1.50	30.24
71	bridle-bit	11.02	0.26	1.91	38.44	0.46	0.81	0.27	3.13	0.07	0.10	0.39	4.89	0.02	0.00	2.20	36.04
75A	bridle-bit	10.15	0.52	2.68	36.31	0.50	0.56	0.25	3.27	0.16	0.08	0.65	9.11	0.08	0.00	1.05	34.64
75B	bridle-bit	11.26	0.46	1.82	36.65	0.35	0.69	0.24	3.15	0.18	0.03	0.56	7.88	0.06	0.00	0.97	35.71
76	bridle-bit	11.22	0.36	1.42	37.81	0.43	0.72	0.22	4.06	0.08	0.03	0.49	7.99	0.00	0.00	1.53	33.65
88A	terret	12.13	0.37	1.80	44.31	0.24	0.76	0.54	5.40	0.06	0.59	0.39	10.15	0.05	0.00	0.42	22.76
88B	terret	12.14	0.36	1.69	44.10	0.22	0.75	0.53	5.39	0.06	0.60	0.45	10.25	0.07	0.00	0.39	22.99
90	terret	12.26	0.41	1.31	44.36	0.26	0.77	0.59	5.42	0.02	0.64	0.40	10.38	0.04	0.00	0.56	22.57
91A	terret	12.22	0.43	1.66	43.95	0.29	0.81	0.58	5.33	0.07	0.66	0.41	9.88	0.07	0.00	1.07	22.57
91B	terret	11.18	0.35	1.57	44.51	0.38	0.82	0.62	5.10	0.09	0.23	0.34	9.69	0.04	0.00	1.16	23.91
94	terret	11.72	0.45	1.63	46.06	0.29	0.74	0.55	5.19	0.07	0.28	0.35	7.04	0.04	0.00	1.03	24.58
95A	terret	12.07	0.44	1.99	39.93	0.26	0.67	0.39	4.12	0.10	0.10	0.63	8.22	0.06	0.00	0.87	30.15
95B	terret	10.70	0.39	1.99	39.87	0.28	0.94	0.35	4.35	0.18	0.11	0.68	7.17	0.01	0.00	1.05	31.95
96A	terret	10.63	0.44	1.81	40.70	0.30	0.57	0.59	4.77	0.09	0.22	0.56	10.50	0.09	0.00	1.11	27.60
96B	terret	10.00	0.39	1.81	40.89	0.25	0.51	0.55	5.02	0.06	0.23	0.52	9.85	0.03	0.00	0.82	29.09
98A	bridle-bit	9.30	0.55	1.91	41.25	0.37	0.64	0.38	5.29	0.10	0.12	0.59	7.50	0.04	0.48	1.42	30.05
98B	bridle-bit	10.03	0.28	1.40	39.62	0.51	0.88	0.27	3.22	0.12	0.11	0.54	7.40	0.00	0.00	1.73	33.88
100A	terret	10.66	0.36	1.49	41.26	0.39	0.75	0.31	3.73	0.07	0.02	0.34	11.98	0.02	0.06	1.50	27.08
100B	terret	10.82	0.59	1.72	41.32	0.36	0.63	0.28	5.02	0.13	0.06	0.53	6.68	0.00	0.03	1.61	30.23
102	terret	9.16	0.43	2.02	40.39	0.34	0.56	0.51	4.78	0.03	0.34	0.51	5.49	0.03	0.00	1.29	34.12
112A	horse brooch	10.18	0.40	1.86	40.71	0.37	0.77	0.52	4.57	0.06	0.30	0.46	7.40	0.14	0.00	1.47	30.79
112B	horse brooch	13.44	1.45	2.80	53.55	1.12	0.67	3.75	9.36	0.22	0.47	1.00	3.76	0.05	0.18	0.81	7.38
113A	horse brooch	11.30	0.39	2.31	42.28	0.36	0.69	0.70	5.54	0.05	0.27	0.61	9.14	0.14	0.04	0.95	25.21
113B	horse brooch	8.16	0.39	1.64	37.51	0.41	0.59	0.47	4.15	0.06	0.35	0.40	10.15	0.09	0.00	1.57	34.05
142A	toggle	11.26	0.41	1.76	36.99	0.42	0.66	0.43	3.35	0.07	0.12	0.77	9.96	0.04	0.00	1.95	31.29
142B	toggle	11.04	0.37	2.07	37.04	0.38	0.74	0.50	3.01	0.15	0.09	0.68	10.55	0.10	0.00	2.12	31.17
143A	toggle	12.47	0.40	1.66	37.99	0.33	0.81	0.18	2.55	0.13	0.09	0.55	7.32	0.00	0.00	1.30	34.23
143B	toggle	12.03	0.47	1.78	41.29	0.41	0.83	0.23	2.56	0.12	0.04	0.64	5.26	0.06	0.00	1.37	32.89
143C	toggle	12.79	0.38	1.72	38.00	0.29	0.70	0.24	2.30	0.15	0.02	0.58	11.78	0.07	0.00	1.39	29.58
7-6 77A	strap union	11.27	0.32	1.70	37.12	0.38	0.82	0.16	3.86	0.07	0.09	0.40	10.47	0.02	0.04	1.66	31.64
7-6 77B	strap union	11.66	0.35	1.59	37.20	0.35	0.82	0.20	3.80	0.11	0.08	0.31	10.84	0.01	0.05	1.62	31.03
7-6 78A	horse brooch	11.90	0.46	1.84	39.18	0.43	0.79	0.45	3.74	0.05	0.11	0.56	9.33	0.05	0.00	1.39	29.73
7-6 78B	horse brooch	12.28	0.42	1.95	39.79	0.39	0.77	0.42	3.85	0.08	0.09	0.66	8.70	0.03	0.01	1.45	29.12
7-6 79	horse brooch	8.97	0.40	1.51	40.69	0.42	0.57	0.59	4.40	0.02	0.30	0.44	9.39	0.00	0.00	1.32	30.98

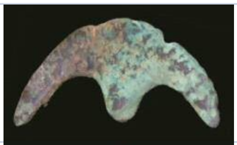
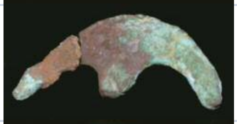
Appendix 5a

Seven Sisters catalogue

Acc. No.	D &S No.	Object	Object type	'Style'	Alloy	Image	weight g
NMW 04.125	16A	bridle-bit ring	horse equipment	geometric	brass (enamel)		87.4g
NMW 04.126	16B	bridle-bit ring	horse equipment	geometric	brass (enamel)		84.9g
NMW 04.127	19	terret	chariot/cart equipment	geometric	brass (enamel)		101.4g
NMW 04.128	20	terret	chariot/cart equipment	geometric	brass (enamel)		107.1g
NMW 04.129	9	terret	chariot/cart equipment	Roman	leaded bronze		51.2g
NMW 04.130	1	strap union	horse equipment	Roman	brass		93.7g
NMW 04.131	17	strap union	horse equipment	geometric	brass (enamel)		99.3g

NMW 04.132	10	buckle	personal military	Roman	bronze		28.2g
NMW 04.133	5	strap slide	horse equipment	Roman	brass		11.8g
NMW 04.134	3	pendant	horse equipment	Roman	brass (silver, niello)		22g
NMW 04.135	4	strap union	horse equipment	Roman	gunmetal (silver)		112.8g
NMW 04.136	14	pendant hook	chariot/cart equipment	curvilinear	bronze (red glass)		112.1g
NMW 04.137	15	pendant hook	chariot/cart equipment	curvilinear	bronze (red glass)		93g
NMW 04.138	21	tankard handle	Vessel	curvilinear	bronze		42.4g
NMW 04.139	22	tankard handle	Vessel	curvilinear	bronze		35.6g
NMW 04.140	23	tankard handle	Vessel	curvilinear	bronze (red glass)		50.1g
NMW 04.141	24	tankard handle	Vessel	curvilinear	bronze (red glass)		42.8g
NMW 04.142	25	tankard handle	Vessel	curvilinear	bronze		10.3g

NMW 04.143	2	disc (phalera)	horse equipment	Roman	brass (tinned)		13.2g
NMW 04.144	13	ring	horse equipment	Roman	bronze		36.2g
NMW 04.145	12	helmet crest	personal military	curvilinear	bronze		61.7g
NMW 04.146	8	bell	chariot/cart equipment	Roman	leaded bronze		23.3g
NMW 04.147	7	bell	chariot/cart equipment	Roman	bronze		39.8g
NMW 04.148	6	fragment (hubb?)	chariot/cart equipment	Roman	gunmetal		52g
NMW 04.149	11	weight	metal working	curvilinear	bronze		309.5g

NMW 04.150	26	ingot	metal working	geometric	brass		204.2g
NMW 04.151	27	ingot	metal working	geometric	brass		147g
NMW 04.152	29	casting jet	metal working	Roman	leaded gunmetal		65.5g
NMW 04.153	30	casting jet	metal working	Roman	leaded bronze		47.8g
NMW 04.154	32	hammered billet	metal working	curvilinear	bronze		12g
NMW 04.155	31	ingot	metal working	Roman	brass		435.4g
NMW 04.156.1	33	sheet	Vessel	curvilinear	bronze		52.1g
NMW 04.156.2	34	sheet	Vessel	curvilinear	bronze		35.5g
NMW 04.156.3	35	sheet	Vessel	curvilinear	bronze		80.8g
NMW 04.156.4	6	sheet	Vessel	curvilinear	bronze		18.5
NMW 04.157	28	lump	metal working	unknown	copper		323g
BM 1928 1-16 1	18	strap union	horse equipment	geometric	brass (enamel)		113g

Appendix 5b

Seven Sisters hoard: metal data normalised to 100% (SEM with EDS/WDS; microprobe) [4]

acc no.	object	analysis type	Fe	Co	Ni	Cu	Zn	As	Sb	Sn	Ag	Bi	Pb	Au
04.125	bit section	SEM WDS/EDS	0.40	0.00	0.09	85.10	14.02	0.11	0.07	0.81	0.00	0.00	0.40	0.00
04.126	bit section	Microprobe	0.41	0.00	0.01	80.58	17.58	0.15	0.02	1.05	0.01	0.00	0.18	0.02
04.127	terret	Microprobe	0.40	0.00	0.02	81.50	16.89	0.05	0.03	0.94	0.02	0.03	0.12	0.00
04.128	terret	Microprobe	0.39	0.01	0.03	80.27	17.78	0.14	0.02	0.95	0.05	0.01	0.36	0.00
04.129	terret	Microprobe	0.04	0.01	0.05	93.38	0.01	0.09	0.07	5.15	0.06	0.01	1.15	0.00
04.130	strap union	SEM EDS			0.07	79.66	17.26	0.07	0.05	2.61	0.27		0.00	
04.131	strap union	Microprobe	0.37	0.00	0.03	79.89	17.52	0.12	0.07	1.27	0.06	0.05	0.60	0.02
04.132	buckle	SEM EDS			0.09	88.05	2.65	0.20	0.00	8.51	0.13		0.36	
04.133	strap slide	SEM EDS			0.10	83.89	14.85	0.03	0.05	0.99	0.00		0.09	
04.134	pendant	SEM EDS			0.03	74.66	23.91	0.22	0.14	0.67	0.37		0.00	
04.135	strap union	Microprobe	0.28	0.01	0.02	79.41	17.37	0.08	0.07	2.25	0.07	0.03	0.35	0.07
04.136	pendant hook	Microprobe	0.04	0.01	0.05	87.43	0.00	0.25	0.07	12.07	0.04	0.01	0.03	0.00
04.137	pendant hook	SEM WDS/EDS	0.05	0.00	0.04	88.00	0.07	0.13	0.00	12.90	0.00	0.00	0.08	0.00
04.138	tankard handle	SEM EDS			0.10	87.75	0.46	0.00	0.00	11.63	0.03		0.03	
04.139	tankard handle	Microprobe	0.14	0.01	0.02	86.63	0.06	0.10	0.00	12.99	0.02	0.00	0.03	0.00
04.140	tankard handle	Microprobe	0.27	0.00	0.00	86.94	0.00	0.00	0.30	12.23	0.12	0.04	0.10	0.00
04.141	tankard handle	Microprobe	0.10	0.01	0.07	87.49	0.01	0.07	0.17	11.84	0.14	0.01	0.10	0.00
04.142	tankard handle	SEM EDS			0.08	87.33	0.04	0.12	0.00	12.37	0.03		0.02	
04.143	phalera	SEM EDS			0.07	79.60	19.76	0.18	0.07	0.13	0.03		0.18	
04.144	ring	SEM EDS			0.10	87.89	0.93	0.19	0.00	10.50	0.08		0.31	
04.145	helmet crest	SEM EDS			0.05	86.00	0.18	0.00	0.00	13.56	0.00		0.20	
04.146	bell	Microprobe	0.26	0.00	0.02	85.39	0.05	0.36	0.04	11.33	0.03	0.00	2.50	0.02
04.147	bell	SEM EDS			0.09	91.71	0.05	0.22	0.00	7.93	0.00		0.00	
04.148	axle cap	SEM EDS			0.05	82.61	13.97	0.05	0.25	2.92	0.15		0.00	
04.149	weight	SEM EDS			0.05	89.41	1.03	0.12	0.00	9.02	0.07		0.30	
04.150	crescentic ingot	Microprobe	0.17	0.01	0.04	80.62	18.94	0.04	0.06	0.01	0.04	0.00	0.08	0.00
04.151	crescentic ingot	SEM EDS			0.17	83.44	16.04	0.00	0.00	0.00	0.25		0.10	
04.152	casting jet	Microprobe	0.06	0.00	0.03	68.97	2.43	0.25	0.13	11.56	0.05	0.03	16.49	0.00
04.153	casting jet	Microprobe	0.00	0.01	0.10	81.62	0.14	0.35	0.27	11.56	0.02	0.01	5.93	0.00
04.154	hammered billet	Microprobe	0.14	0.00	0.05	86.52	0.00	0.09	0.05	12.98	0.04	0.00	0.13	0.00
04.155	ingot	Microprobe	0.19	0.00	0.01	75.73	23.63	0.19	0.02	0.01	0.08	0.00	0.15	0.00
04.156/1	sheet	SQ SEM EDS				87.00				15.00				
04.156/2	sheet	SQ SEM EDS				85.00				15.00				
04.156/3	sheet	SQ SEM EDS				86.00				14.00				
04.156/4	sheet	SQ SEM EDS				87.00				13.00				
04.157	lump	SEM EDS			0.04	99.73	0.00	0.07	0.06	0.04	0.00		0.05	

[4] Microprobe analysis by Peter Northover

Appendix 5c

Seven Sisters hoard: glass data normalised to 100% (SEM with EDS)

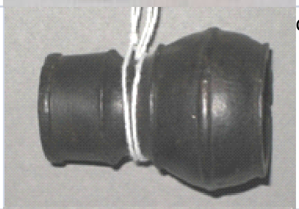
object no.	object	Na2O	MgO	Al2O3	SiO2	P2O5	SO3	Cl	K2O	CaO	TiO2	MnO	FeO	CuO	ZnO	Sb2O3	PbO
4.125	bridlebit	10.86	0.87	1.22	53.86	n/a	0.51	0.32	2.12	5.42	0.09	0.77	0.80	1.99	5.14	1.80	14.24
4.125	bridlebit	10.49	0.75	1.85	49.20	n/a	0.37	0.38	1.44	4.71	0.11	0.72	1.01	0.92	12.38	1.10	14.59
4.125	bridlebit	16.83	0.75	1.13	59.14	n/a	0.31	0.66	2.09	4.53	0.11	0.29	0.97	0.30	11.67	1.15	0.06
4.125	bridlebit	16.16	0.47	1.76	59.46	n/a	0.33	1.07	2.52	4.20	0.10	0.20	1.00	0.52	9.94	1.91	0.35
4.126	bridlebit	12.28	0.61	1.35	59.03	n/a	0.30	1.01	1.23	3.49	0.14	0.22	1.79	1.48	13.40	3.08	0.57
4.126	bridlebit	9.66	0.24	1.55	67.77	n/a	0.46	1.27	0.95	5.30	0.16	0.33	1.02	6.93	0.34	3.96	0.08
4.126	bridlebit	6.94	0.25	0.80	46.37	n/a	1.09	0.77	0.43	3.54	0.08	0.40	0.80	4.34	0.06	1.40	32.72
4.126	bridlebit	7.35	0.38	0.85	47.05	n/a	0.94	0.79	0.59	3.62	0.07	0.45	0.89	2.84	0.49	1.61	32.07
4.127	terret	9.02	0.44	1.15	45.97	n/a	0.54	0.72	0.38	3.44	0.09	0.06	0.61	1.03	3.62	1.19	31.74
4.127	terret	8.95	0.31	1.66	47.10	n/a	0.59	0.64	0.70	4.05	0.11	0.30	0.66	2.14	1.46	1.53	29.80
4.127	terret	14.68	1.08	1.94	58.67	n/a	0.33	1.02	2.13	3.47	0.09	0.19	1.32	0.64	11.51	2.49	0.44
4.127	terret	12.82	0.44	1.62	51.84	n/a	0.67	0.85	1.09	4.59	0.05	0.23	0.83	0.83	6.06	2.18	15.91
4.128	terret	9.93	0.35	1.39	45.88	n/a	0.77	0.63	0.97	4.24	0.11	0.15	0.61	2.55	2.21	1.86	28.37
4.128	terret	11.36	0.39	1.35	48.39	n/a	0.75	0.75	0.96	4.47	0.09	0.21	0.60	0.83	0.49	1.52	27.85
4.128	terret	13.38	0.67	1.35	53.28	n/a	0.65	0.96	0.89	5.37	0.06	0.35	0.71	0.50	0.86	2.94	18.03
4.128	terret	11.07	0.11	1.72	50.88	n/a	0.72	0.85	1.27	4.67	0.14	0.18	0.64	0.74	0.84	1.56	24.61
4.131	strap union	14.73	0.47	1.98	64.04	n/a	0.45	1.14	1.52	5.44	0.14	0.35	0.90	2.05	2.66	3.80	0.33
4.131	strap union	10.50	0.43	1.39	46.53	n/a	0.62	0.62	0.76	3.07	0.08	0.05	0.67	1.36	0.72	1.51	31.69
4.131	strap union	9.98	0.43	1.32	45.83	n/a	0.77	0.59	1.13	2.68	0.14	0.02	0.58	0.90	3.59	1.43	30.62
4.131	strap union	13.76	0.48	1.72	57.81	n/a	0.43	0.99	1.20	4.15	0.15	0.22	0.98	2.22	4.08	2.71	9.11
4.136	pendant hook	10.63	0.33	1.49	39.62	n/a	n/a	0.78	0.23	3.98	0.07	0.13	0.44	8.58	0.00	1.53	32.20
4.136	pendant hook	10.63	0.36	1.44	39.95	n/a	n/a	0.73	0.22	3.99	0.09	0.13	0.51	9.05	0.00	1.65	31.25
4.137	pendant hook	9.14	0.36	1.18	40.72	n/a	n/a	0.61	0.24	3.83	0.05	0.05	0.50	10.06	0.00	1.55	31.72
4.137	pendant hook	10.76	0.38	1.45	40.19	n/a	n/a	0.73	0.27	3.90	0.06	0.18	0.53	9.80	0.00	1.38	30.38
4.140	tankard handle	11.15	0.42	1.58	43.43	0.36	0.37	0.79	0.48	4.07	0.10	0.34	0.55	9.40	0.00	1.26	25.71
4.141	tankard handle	10.17	0.39	1.52	43.25	0.33	0.25	0.74	0.39	4.19	0.04	0.24	0.47	10.41	0.00	1.07	26.53

Appendix 6a

Santon hoard catalogue

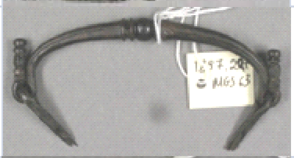
analysis	number	MS no	object	metal	object image (no scale)	category	weight g	length mm
37	1897.222A	1	steelyard	bronze		tool		275
35	1897.222B	2	steelyard pan	bronze		tool		d.51-53
36	1897.222C	3	steelyard weight	leaded bronze		tool		d.38
94	1897.221.MSG4	4	spade/ladle halbfabrikat	bronze		tool	189.6	344
54	1897.227.5	5	anvil	leaded bronze		tool	42.3	37
50	1897.227(6)	6	press mould	leaded bronze		tool	65.2	54
29	1897.227.7	7	press mould	leaded bronze		tool	46.9	55
	1898.228	8	iron tongs	iron		tool		
	1899.228	9	iron tongs	iron		tool		
	1900.228	10	iron file	iron		tool		
	1901.228	11	tanged knife	iron		tool		
	1902.228	12	smith's hammer head	iron		tool		

	1902.228	13	smith's hammer head	iron		tool		
	1903.228	14	implement	iron		tool		
40	1897.224.A	15	dolphin brooch	bronze		personal ornament	11.9	40
46	1897.224.B	16	dolphin brooch	leaded bronze		personal ornament	6	24
45	1897.224.C	17	dolphin brooch	leaded bronze		personal ornament	8.7	42
47	1897.224.D	18	dolphin brooch	bronze		personal ornament	13.1	50
38	1897.224.E	19	Hod Hill Brooch	brass		personal ornament	10	65
39	1897.224.K	20	flat-bowed brooch	brass		personal ornament	4.7	58
41	1897.224.G	21	thistle brooch	brass		personal ornament	48.7	72
52	1897.224.H	22	thistle brooch	leaded gunmetal		personal ornament	19	72
42	1897.224.I	23	thistle brooch	leaded brass and brass		personal ornament		
48	1897.224.J	24	thistle brooch	iron		personal ornament		

8	1897.224.F	25	griffin brooch	leaded bronze		personal ornament	13.6	
2	1897.225A	26	strap union	bronze		horse	93.5	79
3	1897.225B	27	strap union	bronze		horse	79.9	73
30	1897.227.29	28	2-link bridlebit	leaded bronze		horse	195.3	147
17	1897.227.31	29	baluster ferrule	brass		other	52.6	48
16	1897.227.30	30	baluster ferrule	leaded brass		other	54.4	46
49	1879.220.41	31	nave hoop	brass		chariot	174.5	55
43	1879.220.40	32	nave hoop	brass		chariot		d.145
92	1897.220.MSG35	33	nave band	bronze		chariot	254.2	70

93	1897.220.MSG36	34	nave band	bronze		chariot	266.5	70
31	1897.227.20A	35	nave band	bronze		chariot	323.9	
32	1897.227.20B	36	nave band	bronze		chariot	308.1	
31	1897.227.20A	37	nave band tightener for A	bronze		chariot		
32	1897.227.20B	38	nave band tightener for B	bronze		chariot		
	1897.228	39	nave band	iron		chariot		
	1897.228	40	nave band	iron		chariot		
	1897.228	41	nave band tightener	iron		chariot		
	1897.218	42	cauldron	Ae and Fe		vessel		
1	1897.219	43	oenochoe	bronze		vessel	614	190
28	1897.227.46	44	patera handle	leaded bronze		vessel	232.5	133

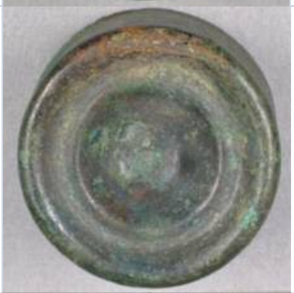
70	1897.179	45	tinned fixing	tinned bronze		other	31.8	30
83	1897.227.48	46	tinned fragment	tinned bronze		other	7.7	
5	1897.227.51A	47	bucket base/rim	bronze		vessel	25	10
6	1897.227.51B	47	bucket base/rim	bronze		vessel	23.3	10
7	1897.227.50	47	bucket handle	bronze		vessel	31	199
62	1897.227.54A	48A1-A4	Bucket mount handle: flat strip tapered perforated X4	high tin bronze with Pb		vessel		
88	1897.227.53A	48B1-B4	Bucket mount hoop fragments: curved sheet strip x4	high tin bronze with Pb		vessel		
88	1897.227.53B	48C1-C2	Bucket mounts hoop fragments: curved sheet	high tin bronze with Pb		vessel fragment		
87	1897.227.55	48D1-D2	Bucket mount hoop fragments: curved sheet	high tin bronze with Pb		vessel fragment	3.3	16
85	1897.227.56	48E	Bucket mount hoop fragment: curved sheet strip hole	high tin bronze with Pb		vessel fragment	2.4	16

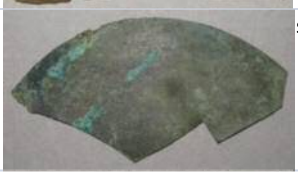
59	1897.227.57	48F	Bucket mount hoop fragment: flat strip	high tin bronze with Pb		vessel fragment	2.1	
77	1897.227.58	48G	Bucket mount hoop-support:	high tin bronze		vessel	10.9	112
74	1897.227.59A	48H	Bucket mount rim-binder: binding strip	very high tin bronze with Pb		vessel	4	d.130
15	1897.223	49	strainer lid with ducks	bronze		vessel	31.9	175
10	1897.227.63	50	drop handle	brass		casket	23.5	91
11	1897.227.61	51	drop handle	leaded bronze		casket	10.2	41
12	1897.227.62	52	drop handle	leaded bronze		casket	8.9	38
13	1897.227.64	53	drop handle	leaded bronze		casket	14.4	54
14	1897.227.65	54	drop handle	leaded bronze		casket	17.3	58
19	1897.227.67	55	casket leg	bronze		casket	10.3	25
23	1897.227.71	56	casket leg	bronze		casket	8.7	29

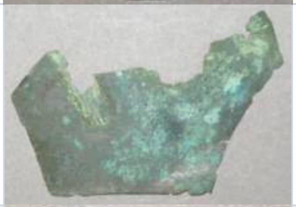
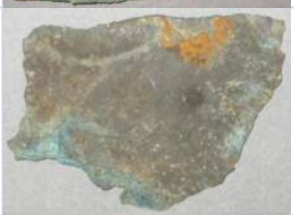
20	1897.227.68	57	casket leg	bronze		casket	9.6	24
22	1897.227.70	58	casket leg	bronze		casket	11.5	26
21	1897.227.69	59	casket leg	bronze		casket	14.8	27
18	1897.227.66	60	casket leg	leaded bronze		casket	15.3	22
24	1897.227.72	61	casket leg	leaded bronze		casket	19.4	23
25	1897.227.73	62	casket leg	leaded bronze		casket	17.9	
26	1897.227.74	63	casket leg	leaded bronze		casket	19.3	24
27	1897.227.75	64	casket leg	leaded bronze		casket	18.3	
4	1897.226	65	embossed strip	bronze		casket	16.8	

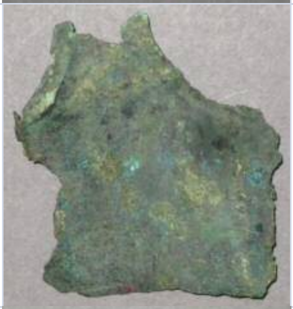
71	1897.226.76A	[65]	embossed strip with stud	gun metal		casket	2.5	
71	1897.226.76B	[65]	embossed strip with stud	bronze		casket	3.2	
71	1897.226.76C	[65]	embossed strip	bronze		casket	2.1	
71	1897.226.76D	[65]	embossed strip	bronze		casket	3.4	
72	1897.226.77.A	[65]	embossed strip	bronze		casket	2.9	
72	1897.226.77.B	[65]	embossed strip	bronze		casket	2.3	
64	1897.227.77A	66	embossed plaque	copper		casket	0.3	28
64	1897.227.77B	66	embossed plaque	copper		casket	0.6	
64	1897.227.77C	66	embossed plaque	copper		casket	0.4	

90	1897.227.78	67	scalloped tinned strip	high tin bronze		vessel		
90	1897.227.78A	67	scalloped tinned strip			vessel fragment		
90	1897.227.78B	67	tinned strip	high tin bronze with Pb		vessel fragment		
90	1897.227.78C	67	tinned strip	high tin bronze with Pb		vessel fragment		
90	1897.227.78D	67	tinned strip	high tin bronze with Pb		vessel fragment		
90	1897.227.78E	67	tinned strip	high tin bronze with Pb		vessel fragment		
90	1897.227.78F	67	tinned strip	high tin bronze with Pb		vessel fragment		
78	1897.227.57A	68	tinned strips	tinned bronze		vessel fragment	3.4	
78	1897.227.57B	68	tinned strips	tinned bronze		vessel fragment	1.5	
78	1897.227.57C	68	tinned strips	tinned bronze		vessel fragment	1.6	
78	1897.227.57D	68	tinned strips	tinned bronze		vessel fragment	2.6	
78	1897.227.57E	68	tinned strips	tinned bronze		vessel fragment	2.5	
78	1897.227.57F	68	tinned strips	tinned bronze		vessel fragment	3.4	
78	1897.227.57G	68	tinned strips	tinned bronze		vessel fragment	3	
78	1897.227.57H	68	tinned strips	tinned bronze		vessel fragment	2.8	
78	1897.227.57I	68	tinned strips	tinned bronze		vessel fragment	2.5	
78	1897.227.57J	68	tinned strips	tinned bronze		vessel fragment	2.2	

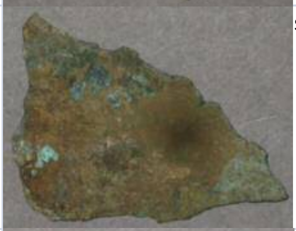
78	1897.227.57K	68	tinned strips	tinned bronze		vessel fragment	3.2	
78	1897.227.57L	68	tinned strips	tinned bronze		vessel fragment	1.3	
78	1897.227.57M	68	tinned strips	tinned bronze		vessel fragment	1.4	
78	1897.227.57N	68	tinned strips	tinned bronze		vessel fragment	0.8	
61	1897.227.80	69	ring	very high tin bronze with Pb		other	0.01	d. 11
68	1897.227.81	70	wax modelling tool	leaded gunmetal		tool		79
69	1897.227.82	71	pin	leaded gunmetal		tool		79
34	1897.227.20D	72	axle cap	brass		chariot	27.6	30
33	1897.227.20C	73	axle cap	brass		chariot	27	30
51	1897.220.85	74	cup (ferrule?)	brass		other	16.4	32
82	1897.227.86	75	ferrule	leaded bronze		other	13.2	20

9	1897.227.89	76A	lorica segmentata hinge lobate	brass		personal military	18.4	56
79	1897.227.87	76B	lorica segmentata hinge rectangular	tinned bronze		personal military	2.7	33
80	1897.227.88	76C	lorica segmentata hinge double	brass		personal military	4.4	14
66	1897.227.92A	77A	scrap sheet fragment	bronze		scrap metal	56.3	
75	1897.227.97A	78	sheet bronze folded coil	brass		scrap metal	37.7	
67	1897.227.91a	79	thin curved sheet strips	bronze		vessel	8.6	
67	1897.227.91b	79	thin curved sheet strips	bronze		vessel	8.8	
67	1897.227.91c	79	thin curved sheet strips	bronze		vessel	9.5	
67	1897.227.91d	79	thin curved sheet strips	bronze		vessel	7.9	
73	1897.227.93	80	cut plate/sheet	brass		scrap sheet	19.6	d.160

66	1897.227.92AD	81A	scrap sheet	brass		scrap sheet	2.9	
66	1897.227.92H	81B	scrap sheet	brass		scrap sheet	9.5	
66	1897.227.92AE	81C	scrap sheet	brass		scrap sheet	6.6	
86	1897.227.95A	82A	strip	brass		scrap sheet	2	85
86	1897.227.95B	82B	strip	brass		scrap sheet	1.6	68
66	1897.227.92AB	83	scrap sheet	copper		scrap metal	1.9	d.25
66	1897.227.92A	84	scrap sheet	bronze		scrap metal	6.6	
66	1897.227.92B	84	scrap sheet	bronze		scrap metal	7.1	
66	1897.227.92C	84	scrap sheet	bronze		scrap metal	3.9	
66	1897.227.92D	84	scrap sheet	bronze		scrap metal	4.8	
66	1897.227.92E	84	scrap sheet	bronze		scrap metal	4.5	
66	1897.227.92F	84	scrap sheet	bronze		scrap metal	14.3	

66	1897.227.92G	84	scrap sheet	bronze		scrap metal	35.4	
66	1897.227.92I	84	scrap sheet	brass		scrap metal	6.1	
66	1897.227.92J	84	scrap sheet	bronze		scrap metal	3.1	
66	1897.227.92K	84	scrap sheet	bronze		scrap metal	2.5	
66	1897.227.92L	84	scrap sheet	bronze		scrap metal	1.1	
66	1897.227.92M	84	scrap sheet	bronze		scrap metal	2	
66	1897.227.92N	84	scrap sheet	bronze		scrap metal	1.2	
66	1897.227.92O	84	scrap sheet	bronze		scrap metal	1.2	
66	1897.227.92P	84	scrap sheet	bronze		scrap metal	1.4	

66	1897.227.92Q	84	scrap sheet	bronze		scrap metal	1.7	
66	1897.227.92R	84	scrap sheet	bronze		scrap metal	0.8	
66	1897.227.92S	84	scrap sheet	bronze		scrap metal	0.7	
66	1897.227.92T	84	scrap sheet	bronze		scrap metal	0.7	
66	1897.227.92U	84	scrap sheet	bronze (tinned face)		scrap metal	1.5	
66	1897.227.92V	84	scrap sheet	bronze		scrap metal	0.5	
66	1897.227.92W	84	scrap sheet	brass		scrap metal	0.5	
66	1897.227.92X	84	scrap sheet	bronze		scrap metal	2.4	

66	1897.227.92Y	84	scrap sheet	bronze		scrap metal	2.1	
66	1897.227.92Z	84	scrap sheet	bronze		scrap metal	0.7	
66	1897.227.92AA	84	scrap sheet	bronze		scrap metal	1.2	
66	1897.227.92AC	84	scrap sheet			scrap metal	4	
76	1897.227.98	85	bent bar square rod	leaded brass		scrap metal	8.8	
81	1897.227.96A	86	curved bar oval section	leaded gunmetal		scrap metal	4.7	
55	1897.218-228.100	87	bent strip	brass		scrap metal	9.4	430
63	1897.227.101A	88	coiled strip	brass		scrap metal	1.7	8
56	1897.227	89	metal lump	leaded gunmetal		scrap metal	23	32
	1897.228	90	stud	iron		metal working		

	1897.228	91	stud in Fe sheet	iron		metal working	
	lost	92	perforated disc	iron		?	
	lost	93	socketed ferrule	iron		ferrule	
	lost	94	socketed ferrule	iron		ferrule	
	lost	95	lump	iron		scrap metal	
60	1897.227.109	96	bone rod with collar	leaded bronze		tool	
58	1897.227.110	97	ferrule on bone tool	gunmetal		tool	
		98	tanged stick	bone		tool	
		99	stick	bone		tool	
		100	handle	bone		tool	
		101	glass bead	glass		personal ornament	
		102	glass bead	glass		personal ornament	
		103	glass bead	glass		personal ornament	
		104	glass bead	glass		personal ornament	
		105	lump	rosin		tool	
		106	leather piece	leather		?	
64	1897.227.101B	107	lead lump	lead		scrap metal	1.8
44	1897.228.40B		hammered strip	brass		scrap metal	
53	1897.228.90		scrap sheet	leaded gunmetal		scrap metal	26.3
57	no number		metal lump	leaded gunmetal		scrap metal	24.4
81	1897.227.96B		thin plate/rod	brass		scrap metal	1.5
89	1897.227.49	(47)	strip, decorated	bronze		vessel	2.7

91	1897.218.B.44		cauldron base	bronze		vessel	129.5
	1897.228		bag of iron fragments	iron		vessel	736.3

Appendix 6b

Santon hoard: metal data normalised to 100% (Bruker XRF)[5]

An	MS	Accession	MnKa1	FeKa1	CoKa1	NiKa1	CuKa1	ZnKa1	AsKa1	PbLb1	BiLb1	AgKa1	SnKa1	SbKa1
37	1	1897.222A steelyard	0.01	0.06	0.00	0.01	84.95	0.44	0.03	0.82	0.18	0.07	13.20	0.26
35	2	1897.222B steelyard pan	0.01	0.09	0.00	0.01	83.55	0.86	0.03	1.19	0.07	0.03	13.93	0.25
36	3	1897.222Csteelyard weight	0.05	0.14	-0.01	0.06	71.36	1.24	0.00	12.29	0.00	0.11	14.19	0.61
94	4	1897.220 spade ladle	0.17	0.98	0.01	0.10	79.20	0.61	0.04	0.63	0.15	0.00	17.86	0.26
54	5	1897.227MSG 102 anvil	0.06	0.60	0.00	0.01	79.87	1.58	0.03	8.44	0.02	0.15	8.65	0.59
50	6	1897.227 MSG 6 stamp mould	1.13	40.03	0.03	0.00	32.77	3.25	0.18	3.33	0.15	0.07	18.58	0.49
29	7	1897.227.7 cast die	0.20	3.50	0.00	0.00	75.45	0.40	0.67	8.14	0.00	0.21	10.75	0.87
	8	pair of tongs												
	9	pair of tongs												
	10	file												
	11	tanged knife												
	12	smith's hammer head												
	13	smith's hammer head												
	14	implement												
40	15	1897.224Abrooch front	0.03	0.35	0.00	0.00	83.27	1.10	0.05	1.54	0.08	0.06	13.27	0.25
40	15	1897.224A brooch hinge	0.08	1.00	0.00	0.00	82.87	3.27	0.04	1.08	0.15	0.12	11.06	0.33
40	15	1897.224A brooch catchplate	0.05	0.41	0.00	0.01	74.12	1.25	0.18	2.35	0.32	0.00	20.72	0.59
46	16	1897.224 B brooch front	0.02	0.10	0.00	0.00	84.11	0.54	0.20	7.12	0.05	0.14	7.43	0.30
46	16	1897.224 B brooch catch plate	0.05	0.54	0.00	0.00	81.97	0.75	0.38	7.81	0.14	0.21	7.74	0.41
45	17	1897.224 C brooch front	0.03	0.33	0.00	0.09	77.83	4.56	0.31	5.91	0.04	0.13	10.52	0.25
45	17	1897.224 C brooch catch plate	0.01	0.14	0.00	0.03	84.55	2.28	0.08	3.75	0.06	0.18	8.66	0.24
47	18	1897.224 D brooch catchplate	0.05	0.67	0.00	0.00	76.61	0.72	0.16	1.66	0.28	0.05	19.34	0.43
47	18	1897.224 D brooch front	1.27	47.66	0.03	0.00	20.10	1.71	0.11	1.03	0.23	0.00	27.47	0.39
38	19	1897.224E brooch	0.03	0.50	0.01	0.00	79.80	16.66	0.06	0.77	0.11	0.14	1.76	0.20
39	20	1897.224K brooch reverse	0.06	0.80	0.02	0.00	78.78	14.12	0.23	3.79	0.25	0.34	1.26	0.41
39	20	1897.224K brooch front	0.03	0.58	0.00	0.00	84.89	12.80	0.05	0.52	0.03	0.07	0.96	0.09
41	21	1897.224G brooch front	0.06	0.97	0.00	0.00	83.16	12.81	0.07	1.11	0.04	0.09	1.62	0.07
41	21	1897.224G brooch front tail	1.37	90.45	0.00	0.00	-26.89	14.78	0.15	4.48	0.22	0.08	15.06	0.30
41	21	1897.224G brooch reverse	0.12	1.66	0.01	0.00	77.57	15.25	0.20	2.38	0.20	0.29	2.07	0.27
52	22	1897.224 H brooch front tail	0.03	0.48	0.00	0.00	75.23	6.86	1.04	6.68	0.05	0.13	9.19	0.30
52	22	1897.224 H brooch back	0.10	0.90	0.03	0.00	77.92	9.88	0.00	3.87	0.61	0.54	5.31	0.83
52	22	1897.224 H brooch hinge	0.04	0.63	0.00	0.00	79.29	10.38	0.15	4.66	0.01	0.08	4.64	0.12
52	22	1897.224 H brooch dome	0.02	0.27	0.00	0.00	89.90	8.97	0.04	0.50	0.04	0.06	0.15	0.07
42	23	1897.224I brooch front	1.45	54.47	0.00	0.00	34.39	4.30	0.23	3.28	0.10	0.19	1.29	0.29
42	23	1897.224I brooch back	0.07	0.75	0.02	0.00	84.52	11.43	0.01	1.31	0.24	0.28	1.01	0.35
42	23	1897.224Ibrooch front tail	0.16	2.73	0.01	0.00	81.03	13.86	0.04	0.94	0.06	0.10	0.93	0.15
48	24	1897.224 J brooch front	0.07	1.19	0.00	0.00	80.86	9.18	0.17	4.92	0.00	0.09	3.37	0.15
48	24	1897.224 J brooch back	0.10	1.10	0.02	0.00	77.07	9.73	0.28	6.74	0.25	0.34	3.88	0.50
48	24	1897.224 J brooch catchplate	0.08	1.41	0.00	0.00	78.66	11.72	0.11	4.52	0.03	0.11	3.20	0.15
8	25	1897.224.F griffin brooch back plate	0.01	0.15	0.00	0.00	58.35	0.33	0.84	5.45	0.15	0.00	34.39	0.34
8	25	1897.224.F griffin brooch middle plate	0.02	0.19	0.00	0.00	61.51	0.34	0.04	1.59	0.19	0.00	35.95	0.19
8	25	1897.224.F griffin brooch top plate front	0.13	1.89	0.00	0.00	66.06	0.40	0.04	0.94	0.21	0.00	30.06	0.27
8	25	1897.224.F griffin brooch top plate front reverse	0.01	0.22	0.00	0.00	73.10	0.28	0.79	7.77	0.00	0.00	17.64	0.17
2	26	1897.225A quadrilobe strap union	0.02	0.24	0.00	0.06	81.41	1.16	0.06	3.10	0.19	0.13	13.37	0.52
3	27	1897.225B quadrilobe strap union	0.00	0.04	0.00	0.06	86.11	0.47	0.12	2.06	0.07	0.14	10.55	0.38
30	28	1897.227.29b snaffle bit ring	0.03	0.52	0.00	0.00	80.89	0.84	0.30	8.33	0.04	0.18	8.47	0.41
30	28	1897.227.29c snaffle bit link	0.02	0.20	0.00	0.02	76.59	0.45	0.47	7.90	0.03	0.09	13.64	0.58
17	29	1897.227.31 balluster ferrule	0.09	1.43	0.00	0.00	90.18	6.31	0.05	0.66	0.04	0.09	1.08	0.15
16	30	1897.227.30 balluster ferrule	0.03	0.63	0.00	0.00	87.81	8.79	0.07	1.03	0.03	0.09	1.40	0.14
49	31	1897.228.41 nave hoop (decorated)	0.08	0.40	0.03	0.00	77.74	18.02	0.00	1.28	0.46	0.50	0.92	0.57
43	32	1897.228.40 nave hoop	0.03	0.53	0.00	0.00	83.76	14.48	0.05	0.20	0.05	0.09	0.70	0.11
92	33	1897.220 cart nave band	0.02	0.09	0.00	0.02	84.45	0.32	0.00	0.32	0.10	0.03	14.43	0.23
93	34	1897.220 cart nave band	0.02	0.14	0.00	0.02	84.85	0.32	0.01	0.25	0.09	0.04	14.03	0.25
31	35	1897.220A 2 part nave band main part	0.04	0.21	0.00	0.00	83.47	0.44	0.01	0.74	0.12	0.04	14.71	0.26
32	36	1897.220B 2 part nave band main part	0.03	0.13	0.00	0.01	85.14	0.41	0.01	0.31	0.09	0.05	13.62	0.23
31	37	1897.220A 2 part nave band rim (tightener)	0.04	0.47	0.00	0.00	83.78	1.42	0.01	1.50	0.09	0.10	12.31	0.30
32	38	1897.220B 2 part nave band rim (tightener)	0.05	0.53	0.00	0.00	80.77	1.80	0.06	1.94	0.09	0.07	14.41	0.34
	39	1897.220 cart nave band												
	40	1897.220 cart nave band												
	41	1897.220 cart nave band tightener												
	42	Cauldron												
1	43	1847.219 jug body	0.06	1.12	0.00	0.00	91.43	0.55	0.00	0.30	0.06	0.04	6.64	0.07
1	43	1847.219 jug base	0.02	0.07	0.00	0.00	80.76	0.26	0.00	0.33	0.13	0.00	18.26	0.16

[5] Blue shaded areas represent multiple readings from the same object.

28	44	28 1897.227.46 patera handle	0.05	0.46	0.00	0.03	75.08	0.29	0.58	8.59	0.00	0.14	13.72	1.07
70	45	1897.179.78 tinned object	0.14	2.10	0.00	0.00	67.15	0.37	0.00	0.41	0.20	0.00	29.45	0.17
83	46	1897.227.48 curved tinned fragment outer (bowl)	0.01	0.11	0.00	0.00	74.17	0.26	0.00	0.32	0.15	0.00	24.88	0.12
83	46	1897.227.48 curved tinned fragment inner (bowl)	0.21	0.52	0.06	0.16	73.02	0.49	0.00	3.49	3.07	0.00	15.35	3.63
15	49	1897.223 strainer lid	0.11	1.42	0.01	0.06	78.39	0.39	0.27	0.90	0.62	0.03	17.29	0.62
15	49	1897.223 strainer lid front patch	0.07	0.38	0.02	0.05	79.89	0.32	0.20	0.64	0.52	0.07	17.28	0.55
15	49	1897.223 strainer ducks	0.22	3.09	0.00	0.00	203.31	3.32	0.00	######	0.00	0.89	46.70	2.24
10	50	1897.227.63 handle	0.02	0.29	0.00	0.00	89.75	8.62	0.04	0.61	0.09	0.16	0.23	0.19
11	51	1897.227.61 handle	0.03	0.30	0.00	0.01	79.90	1.02	0.27	7.58	0.06	0.21	10.20	0.44
12	52	1897.227.62 handle	1.20	0.89	0.05	0.00	71.23	4.14	0.11	7.73	0.47	0.25	12.97	0.97
13	53	1897.227.64 handle	0.02	0.25	0.00	0.00	82.41	1.01	0.13	6.26	0.04	0.15	9.39	0.35
14	54	1897.227.65 handle	0.03	0.26	0.00	0.02	82.66	1.02	0.11	5.80	0.11	0.19	9.41	0.41
19	55	1897.227.67a casket leg	0.03	0.28	0.00	0.00	89.61	0.43	0.03	0.70	0.12	0.10	8.55	0.15
23	56	1897.227.71 casket leg	0.03	0.20	0.00	0.00	89.44	0.48	0.05	1.12	0.12	0.11	8.28	0.17
20	57	1897.227.68a casket leg	0.03	0.20	0.00	0.00	89.29	0.67	0.07	0.96	0.11	0.09	8.43	0.14
22	58	1897.227.70 casket leg	0.04	0.34	0.00	0.00	88.74	0.48	0.04	0.78	0.10	0.08	9.28	0.13
21	59	1897.227.69a casket leg	0.03	0.20	0.00	0.00	89.34	0.45	0.04	0.89	0.10	0.10	8.70	0.15
18	60	1897.227.66a casket leg	0.02	0.19	0.00	0.01	86.14	0.66	0.09	4.73	0.14	0.20	7.30	0.51
24	61	1897.227.72 casket leg	0.05	0.40	0.00	0.02	82.76	0.59	0.06	5.40	0.15	0.20	9.90	0.48
25	62	1897.227.73 casket leg	0.19	3.07	0.00	0.00	75.76	0.50	0.13	7.58	0.13	0.15	11.95	0.54
26	63	1897.227.74 casket leg	1.30	50.77	0.06	0.00	28.75	0.56	0.04	7.07	0.23	0.29	10.32	0.62
27	64	1897.227.75 casket leg	1.44	94.64	0.10	0.00	-17.29	1.12	0.26	9.30	0.20	0.32	8.98	0.93
4	65	1897.226 embossed strip	0.10	1.32	0.00	0.00	76.18	0.72	0.06	1.31	0.16	0.00	19.95	0.20
71	65	1897.226.76Aa embossed strip fragment	0.08	1.17	0.00	0.00	81.62	1.23	0.01	0.59	0.13	0.03	14.99	0.16
71	65	1897.226.76B embossed strip fragment	0.14	2.21	0.00	0.00	80.97	0.29	0.01	0.46	0.14	0.02	15.62	0.14
71	65	1897.226.76C embossed strip fragment	0.04	0.32	0.00	0.00	77.41	0.59	0.08	1.22	0.12	0.00	20.08	0.15
71	65	1897.226.76Ab embossed strip stud	0.06	0.52	0.00	0.00	77.75	0.61	0.06	1.18	0.14	0.00	19.51	0.17
72	65	1897.226.77A embossed strip fragment	0.02	0.13	0.00	0.00	80.81	0.37	0.01	0.57	0.13	0.00	17.82	0.14
72	65	1897.226.77B embossed strip fragment	0.02	0.22	0.00	0.00	80.02	0.50	0.06	0.86	0.10	0.00	18.08	0.13
64	66	1897.227.77A embossed plaque front	0.02	0.16	0.00	0.00	98.80	0.48	0.01	0.14	0.08	0.11	0.15	0.06
64	66	1897.227.77A embossed plaque back	0.03	0.35	0.00	0.00	97.93	0.99	0.02	0.36	0.04	0.05	0.19	0.05
64	66	1897.227.77B embossed plaque	0.02	0.15	0.00	0.00	98.87	0.50	0.01	0.14	0.06	0.07	0.13	0.05
64	66	1897.227.77C embossed plaque	0.02	0.25	0.00	0.00	98.39	0.67	0.03	0.36	0.03	0.04	0.15	0.06
90	67	1897.227.78A tinned bucket frag outer	0.02	0.20	0.00	0.00	74.73	0.34	0.00	0.37	0.16	0.00	24.04	0.14
90	67	1897.227.78A tinned bucket frag inner	0.01	0.04	0.00	0.00	77.28	0.78	0.00	0.46	0.20	0.00	21.05	0.18
90	67	1897.227.78A tinned bucket frag bronze edging	0.01	0.16	0.00	0.00	78.10	0.31	0.00	0.45	0.19	0.00	20.62	0.17
90	67	1897.227.78B tinned bucket frag outer	0.00	0.04	0.00	0.00	75.12	0.33	0.00	0.32	0.15	0.00	23.91	0.13
90	67	1897.227.78B tinned bucket frag inner	0.01	0.06	0.00	0.00	68.14	0.67	0.00	0.43	0.16	0.00	30.40	0.13
78	68	1897.227.79A tinned strip with edging front	0.00	0.01	0.00	0.00	84.51	0.35	0.00	0.39	0.10	0.02	14.52	0.10
78	68	1897.227.79A tinned strip with edging back	0.00	0.01	0.00	0.00	90.38	0.55	0.00	0.27	0.06	0.06	8.60	0.07
78	68	1897.227.79E tinned strip with edging front	0.01	0.03	0.00	0.00	79.41	0.36	0.00	0.46	0.14	0.00	19.48	0.11
78	68	1897.227.79E tinned strip with edging back	0.00	0.01	0.00	0.00	90.26	0.44	0.00	0.26	0.05	0.06	8.85	0.06
78	68	1897.227.79F tinned strip with edging front	0.01	0.07	0.00	0.00	87.19	0.37	0.01	0.28	0.11	0.06	11.73	0.18
78	68	1897.227.79F tinned strip with edging back	0.01	0.06	0.00	0.00	94.33	0.46	0.01	0.10	0.05	0.07	4.81	0.10
78	68	1897.227.79K tinned strip with edging front	0.01	0.05	0.00	0.00	88.29	0.35	0.01	0.22	0.10	0.06	10.74	0.17
78	68	1897.227.79K tinned strip with edging back	0.01	0.06	0.00	0.00	94.62	0.37	0.02	0.09	0.04	0.07	4.62	0.10
78	68	1897.227.79B tinned strip with edging front	0.01	0.05	0.00	0.00	89.82	0.37	0.01	0.25	0.09	0.07	9.16	0.17
78	68	1897.227.79B tinned strip with edging back	0.01	0.06	0.00	0.00	94.59	0.40	0.01	0.11	0.04	0.07	4.60	0.11
78	68	1897.227.79C tinned strip with edging front	0.00	0.06	0.00	0.00	88.49	0.37	0.01	0.23	0.10	0.06	10.51	0.17
78	68	1897.227.79C tinned strip with edging back	0.01	0.07	0.00	0.00	94.22	0.44	0.02	0.11	0.04	0.07	4.93	0.10
78	68	1897.227.79D tinned strip with edging front	0.02	0.19	0.00	0.00	86.35	0.45	0.00	0.24	0.11	0.04	12.41	0.19
78	68	1897.227.79D tinned strip with edging back	0.01	0.08	0.00	0.00	94.66	0.46	0.01	0.11	0.04	0.07	4.44	0.10
78	68	1897.227.79G tinned strip with edging front	0.01	0.07	0.00	0.00	89.96	0.39	0.02	0.27	0.09	0.07	8.97	0.15
78	68	1897.227.79G tinned strip with edging back	0.01	0.07	0.00	0.00	94.53	0.45	0.01	0.13	0.05	0.07	4.58	0.11
78	68	1897.227.79H tinned strip with edging front	0.01	0.06	0.00	0.00	89.72	0.35	0.02	0.19	0.09	0.06	9.35	0.15
78	68	1897.227.79H tinned strip with edging back	0.01	0.06	0.00	0.00	94.30	0.56	0.01	0.12	0.05	0.07	4.72	0.11
78	68	1897.227.79I tinned strip with edging front	0.01	0.06	0.00	0.00	85.90	0.37	0.01	0.29	0.12	0.04	13.02	0.18
78	68	1897.227.79I tinned strip with edging back	0.01	0.06	0.00	0.00	94.35	0.45	0.01	0.12	0.05	0.07	4.77	0.10
78	68	1897.227.79Jtinned strip with edging front	0.01	0.06	0.00	0.00	89.08	0.36	0.01	0.25	0.10	0.07	9.89	0.17
78	68	1897.227.79J tinned strip with edging back	0.01	0.07	0.00	0.00	94.50	0.41	0.01	0.11	0.04	0.07	4.69	0.10
78	68	1897.227.79L tinned strip with edging front	0.01	0.03	0.00	0.00	76.39	0.34	0.00	0.47	0.15	0.00	22.49	0.13
78	68	1897.227.79L tinned strip with edging back	0.00	0.02	0.00	0.00	90.18	0.54	0.00	0.28	0.06	0.06	8.79	0.07
78	68	1897.227.79M tinned strip with edging front	0.01	0.07	0.00	0.00	85.82	0.44	0.02	0.33	0.11	0.04	12.99	0.17
78	68	1897.227.79M tinned strip with edging back	0.01	0.07	0.00	0.00	94.64	0.39	0.01	0.09	0.04	0.06	4.59	0.10
78	68	1897.227.79N tinned strip with edging front	0.00	0.04	0.00	0.00	86.96	0.48	0.00	0.36	0.09	0.04	11.92	0.10
78	68	1897.227.79N tinned strip with edging back	0.00	0.03	0.00	0.00	89.45	0.54	0.00	0.31	0.07	0.06	9.48	0.07
61	69	1897.227.80 washer/ring front	0.05	0.52	0.00	0.00	60.93	0.43	0.00	1.23	0.56	0.00	35.79	0.49
61	69	1897.227.80 washer/ring back	0.07	0.67	0.00	0.00	51.36	0.68	0.13	2.85	0.59	0.00	43.10	0.55
68	70	1897.227.81 modelling tool	0.02	0.20	0.00	0.01	88.73	2.42	0.03	3.02	0.25	0.37	4.48	0.48
69	71	1897.227.82 pin	0.27	5.13	0.00	0.00	77.08	10.15	0.05	1.98	0.58	0.67	3.54	0.81
34	72	1897.220D axle cap	0.02	0.31	0.00	0.00	83.99	14.68	0.02	0.32	0.04	0.07	0.44	0.13

33	73	1897.220C axle cap	0.01	0.19	0.00	0.00	82.19	16.62	0.03	0.25	0.04	0.08	0.47	0.13
51	74	1897.220.85 domed ferrule/cup	0.02	0.32	0.00	0.00	84.42	13.83	0.06	0.57	0.03	0.09	0.51	0.14
82	75	1897.227.86 ferrule	0.01	0.12	0.00	0.00	77.96	0.38	0.24	4.32	0.07	0.01	16.52	0.37
66	77	1897.227.92AF sheet metal	0.03	0.47	0.00	0.00	80.87	16.86	0.06	0.63	0.04	0.10	0.79	0.14
67	79	1897.227.91a sheet metal	0.01	0.07	0.00	0.27	82.05	0.43	0.00	0.24	0.13	0.00	16.70	0.10
67	79	1897.227.91b sheet metal	0.02	0.10	0.00	0.27	80.94	0.48	0.00	0.22	0.10	0.00	17.83	0.06
67	79	1897.227.91c sheet metal	0.02	0.10	0.00	0.27	81.71	0.33	0.00	0.25	0.13	0.00	17.10	0.10
67	79	1897.227.91d sheet metal	0.01	0.06	0.00	0.30	79.92	0.37	0.03	0.43	0.10	0.00	18.74	0.06
73	80	1897.227.93 cut sheet frag	0.02	0.42	0.00	0.00	82.82	16.19	0.02	0.16	0.04	0.08	0.15	0.12
86	82	1897.227.95A curved fragment inner	0.03	0.50	0.00	0.00	80.26	18.64	0.02	0.20	0.04	0.09	0.14	0.08
86	82	1897.227.95B curved fragment inner	0.02	0.29	0.01	0.00	78.34	20.52	0.03	0.43	0.03	0.09	0.16	0.07
66	83	1897.227.92AA sheet metal	0.01	0.10	0.00	0.00	79.41	0.32	0.06	0.29	0.12	0.00	19.07	0.63
76	85	1897.227.98 bent rod	0.07	1.05	0.00	0.00	82.19	12.03	0.29	3.21	0.12	0.28	0.50	0.32
81	86	1897.227.96A curved rod	0.16	2.60	0.00	0.00	51.81	3.26	0.43	4.60	0.52	0.00	35.75	0.87
55	87	1897.218-228.100b strip	0.05	0.89	0.00	0.00	87.40	10.10	0.11	0.95	0.05	0.11	0.20	0.15
63	88	1897.227.101A coiled strip	0.05	0.84	0.01	0.00	76.04	21.93	0.06	0.64	0.06	0.09	0.20	0.09
56	89	copper alloy lump	0.10	1.26	0.00	0.00	78.39	4.96	0.20	4.65	0.05	0.14	10.00	0.26
60	96	1897.227.109 bone with metal ring	0.51	4.77	0.01	0.00	67.03	0.94	0.62	5.32	0.52	0.02	19.21	1.56
58	97	1897.227.110 bone with metal ring	0.47	10.12	0.00	0.00	66.73	2.76	0.01	1.17	0.33	0.10	17.64	1.14
64	107	1897.227.101B lead lump												
84	?48	1897.227.52A curved fragment inner	0.15	2.24	0.00	0.00	55.58	0.45	0.79	6.06	0.39	0.00	33.78	0.58
84	?48	1897.227.52A curved fragment outer	0.06	0.95	0.00	0.00	70.39	0.37	0.41	3.34	0.15	0.00	24.11	0.23
84	?48	1897.227.52B curved fragment outer	0.32	5.98	0.00	0.00	57.56	0.37	0.62	4.74	0.21	0.00	29.86	0.34
84	?48	1897.227.52B curved fragment inner	0.22	3.95	0.00	0.00	58.04	0.72	0.95	6.36	0.16	0.00	29.26	0.34
88	?48	1897.227.53C curved fragment outer	0.14	2.29	0.00	0.00	65.58	0.70	0.68	6.08	0.10	0.00	24.20	0.22
88	?48	1897.227.53C curved fragment inner	0.07	1.19	0.00	0.00	68.66	0.68	0.81	5.63	0.10	0.00	22.63	0.23
7	47A	1897.227.50 bucket handle rim	0.02	0.11	0.01	0.08	83.19	0.79	0.18	0.14	0.14	0.02	15.15	0.19
5	47B	1897.227.51A bucket base circumference	0.02	0.14	0.00	0.00	81.56	0.64	0.05	1.79	0.09	0.01	15.56	0.14
5	47B	1897.227.51A bucket base circumference tinned face	0.01	0.03	0.00	0.00	74.80	0.74	0.00	1.72	0.14	0.00	22.37	0.18
6	47C	1897.227.51B bucket base circumference	0.00	0.02	0.00	0.00	83.33	0.53	0.00	1.61	0.10	0.03	14.24	0.14
6	47C	1897.227.51B bucket base circumference tinned face	0.01	0.03	0.00	0.00	72.89	0.60	0.00	1.68	0.16	0.00	24.47	0.19
62	48A	1897.227.54A flat strip with hole front	0.11	1.77	0.00	0.00	70.85	0.34	0.41	3.59	0.14	0.00	22.54	0.25
62	48A	1897.227.54A flat strip with hole back	0.26	4.73	0.00	0.00	67.20	0.35	0.54	4.66	0.12	0.00	21.88	0.26
62	48A	1897.227.54B flat strip front	0.10	1.64	0.00	0.00	57.46	0.66	1.10	6.36	0.13	0.00	32.24	0.30
62	48A	1897.227.54B flat strip back	0.06	1.02	0.00	0.00	68.94	0.66	0.82	5.62	0.12	0.00	22.51	0.24
88	48B	1897.227.53A curved fragment outer	0.06	0.98	0.00	0.00	67.74	0.65	0.82	5.85	0.09	0.00	23.59	0.21
88	48B	1897.227.53A curved fragment inner	0.10	1.71	0.00	0.00	66.05	0.70	0.98	5.97	0.10	0.00	24.13	0.26
88	48C	1897.227.53B curved fragment inner	0.13	2.26	0.00	0.00	67.67	0.69	0.55	5.59	0.10	0.00	22.77	0.24
88	48C	1897.227.53B curved fragment outer	0.14	2.39	0.00	0.00	52.61	0.95	1.03	7.08	0.13	0.00	35.30	0.37
88	48C	1897.227.53D curved fragment inner	0.13	2.23	0.00	0.00	63.34	0.68	0.86	6.32	0.10	0.00	26.10	0.25
88	48C	1897.227.53D curved fragment outer	0.13	2.27	0.00	0.00	54.35	0.82	1.22	6.54	0.12	0.00	34.23	0.33
87	48D	1897.227.55A curved fragment inner	0.03	0.44	0.00	0.00	74.93	0.70	0.47	4.25	0.11	0.00	18.88	0.19
87	48D	1897.227.95B curved fragment outer	0.07	1.04	0.00	0.00	75.98	0.66	0.43	4.67	0.06	0.03	16.88	0.17
85	48E	1897.227.56 curved fragment outer	0.02	0.28	0.00	0.00	75.69	0.69	0.60	5.02	0.05	0.03	17.45	0.16
85	48E	1897.227.56 curved fragment inner	0.12	1.71	0.00	0.00	68.36	0.75	0.75	5.65	0.17	0.00	22.22	0.29
59	48F	1897.227.57 flat strip front	0.10	1.65	0.00	0.00	66.44	0.72	0.71	5.78	0.10	0.00	24.27	0.23
59	48F	1897.227.57 flat strip back	0.12	1.98	0.00	0.00	61.64	0.75	0.91	5.98	0.17	0.00	28.11	0.35
77	48G	1897.227.58 dec strip with rivet holes front	0.05	0.82	0.00	0.00	72.05	0.69	1.23	5.09	0.04	0.00	19.84	0.19
77	48G	1897.227.58 dec strip with rivet holes back	0.06	1.05	0.00	0.00	74.55	0.65	0.39	5.01	0.09	0.03	17.97	0.19
74	48H	1897.227.59B binding frag	0.29	5.53	0.00	0.00	50.74	0.84	1.12	6.44	0.32	0.00	34.25	0.48
74	48H	1897.227.59B binding frag reverse	0.24	4.41	0.00	0.00	50.51	0.76	0.90	6.90	0.37	0.00	35.33	0.57
74	48H	1897.227.59A binding frag	0.29	5.51	0.00	0.00	45.33	0.73	1.65	4.19	0.33	0.00	41.43	0.54
9	76A	1897.227.89 scroll hinge	0.07	1.23	0.01	0.00	78.93	16.86	0.03	0.87	0.07	0.12	1.64	0.16
79	76B	1897.227.87 lorica segmentata hinge back	0.01	0.07	0.00	0.05	85.62	0.47	0.04	1.39	0.07	0.05	12.03	0.22
79	76B	1897.227.87 lorica segmentata hinge front	0.01	0.19	0.00	0.02	71.33	0.62	0.05	2.26	0.16	0.00	25.02	0.34
80	76C	1897.227.88 lorica segmentata hinge front	0.63	14.88	0.01	0.00	71.35	11.01	0.03	0.49	0.08	0.17	1.10	0.25
66	81A	1897.227.92AD sheet metal	0.01	0.25	0.01	0.00	79.27	20.03	0.06	0.11	0.03	0.05	0.11	0.05
66	81B	897.227.92H sheet metal	0.01	0.30	0.01	0.00	84.28	14.88	0.02	0.14	0.03	0.07	0.15	0.10
66	81C	1897.227.92AE sheet metal	0.05	0.68	0.00	0.00	85.34	12.08	0.05	0.37	0.04	0.10	1.08	0.23
44		1897.228 B strip front	0.08	1.22	0.00	0.00	88.75	7.84	0.12	0.44	0.08	0.15	1.12	0.19
44		1897.228 B strip back	0.04	0.45	0.00	0.00	87.02	10.91	0.03	0.33	0.09	0.13	0.83	0.17
53		1897.228.90 scrap metal piece	0.04	0.73	0.00	0.00	83.06	8.01	0.20	5.12	0.03	0.29	2.38	0.14
57		copper alloy lump B	0.07	0.83	0.00	0.00	84.70	10.57	0.04	1.19	0.10	0.18	2.04	0.27
66		1897.227.92A sheet metal back	0.04	0.19	0.00	0.02	80.40	0.30	0.06	0.38	0.24	0.05	17.43	0.90
66		1897.227.92B sheet metal front	0.04	0.54	0.00	0.02	80.95	0.32	0.07	0.27	0.12	0.07	16.88	0.72
66		1897.227.92C sheet metal front	0.03	0.31	0.00	0.00	80.51	0.43	0.07	0.34	0.13	0.00	17.87	0.32
66		1897.227.92D sheet metal front	0.01	0.09	0.00	0.00	80.55	0.31	0.05	0.23	0.11	0.03	18.05	0.57
66		1897.227.92E sheet metal front with rivet	0.08	1.00	0.00	0.01	82.08	0.34	0.09	0.45	0.10	0.12	15.11	0.62
66		1897.227.92F sheet metal front with rove	0.10	1.27	0.00	0.00	74.48	0.52	0.14	0.29	0.19	0.00	21.96	1.07
66		1897.227.92G sheet metal	0.10	1.27	0.00	0.00	80.81	0.80	0.03	0.46	0.23	0.06	16.01	0.23

66		1897.227.92I sheet metal	0.01	0.34	0.00	0.00	82.02	16.14	0.05	0.38	0.03	0.07	0.84	0.11
66		1897.227.92J sheet metal	0.01	0.05	0.00	0.00	83.88	0.29	0.06	0.44	0.11	0.11	14.57	0.49
66		1897.227.92K sheet metal	0.02	0.12	0.00	0.01	78.88	0.31	0.04	0.40	0.18	0.00	19.34	0.70
66		1897.227.92L sheet metal	0.08	0.87	0.00	0.00	78.16	0.32	0.11	0.12	0.12	0.00	19.40	0.82
66		1897.227.92M sheet metal	0.03	0.26	0.00	0.00	76.02	0.34	0.13	0.19	0.15	0.00	21.91	0.97
66		1897.227.92N sheet metal	0.03	0.10	0.00	0.00	78.09	0.35	0.07	0.51	0.13	0.00	20.08	0.62
66		1897.227.92O sheet metal	0.01	0.09	0.00	0.00	79.98	0.33	0.06	0.28	0.11	0.01	18.55	0.59
66		1897.227.92P sheet metal	0.02	0.11	0.00	0.01	75.22	0.37	0.19	0.50	0.18	0.00	22.43	0.98
66		1897.227.92Q sheet metal 4 rivets	0.00	0.05	0.00	0.04	82.92	0.33	0.05	0.25	0.14	0.11	15.41	0.70
66		1897.227.92R sheet metal	0.01	0.06	0.00	0.00	83.88	0.46	0.03	0.39	0.07	0.00	15.01	0.10
66		1897.227.92S sheet metal	0.02	0.11	0.00	0.00	83.95	0.36	0.07	0.38	0.08	0.01	14.80	0.23
66		1897.227.92T sheet metal	0.04	0.29	0.00	0.00	80.09	0.32	0.06	0.24	0.12	0.02	18.25	0.57
66		1897.227.92U sheet metal tinned face	0.01	0.01	0.00	0.00	68.87	0.31	0.00	0.37	0.17	0.00	30.13	0.13
66		1897.227.92Ub sheet metal back face	0.04	0.10	0.01	0.01	76.78	0.30	0.00	0.75	0.40	0.00	21.22	0.39
66		1897.227.92V sheet metal	0.01	0.14	0.00	0.01	78.05	0.33	0.07	0.30	0.13	0.00	20.30	0.67
66		1897.227.92W sheet metal	0.03	0.37	0.00	0.00	84.97	14.17	0.02	0.11	0.03	0.07	0.14	0.09
66		1897.227.92X sheet metal	0.08	0.87	0.00	0.00	80.05	0.33	0.02	0.62	0.29	0.09	16.81	0.85
66		1897.227.92Y sheet metal	0.00	0.05	0.00	0.00	85.92	0.32	0.06	0.50	0.09	0.04	12.79	0.22
66		1897.227.92Z sheet metal	0.02	0.12	0.00	0.02	85.28	0.33	0.03	0.23	0.08	0.15	13.19	0.55
66		1897.227.92AB sheet metal	0.03	0.31	0.00	0.00	97.89	0.84	0.05	0.41	0.03	0.14	0.23	0.07
66		1897.227.92AC sheet metal	1.54	74.85	0.02	0.00	3.77	0.70	0.00	0.54	0.21	0.06	17.97	0.33
66		1897.227.92AFb sheet metal	0.06	0.94	0.00	0.00	72.89	7.41	0.85	8.01	0.00	7.66	2.05	0.20
75		1897.227.97A folded sheet	0.14	2.44	0.00	0.00	85.45	9.96	0.07	0.90	0.05	0.08	0.95	0.10
75		1897.227.97B folded sheet	0.06	0.92	0.00	0.00	83.21	14.24	0.09	0.67	0.03	0.08	0.63	0.13
81		1897.227.96Ba small strip, thin plate, rod	0.22	4.07	0.01	0.00	62.27	18.16	0.12	2.91	0.12	0.17	11.79	0.16
81		1897.227.96Bb small strip, thin plate, rod	0.09	1.43	0.00	0.00	84.24	11.73	0.08	1.01	0.09	0.12	1.10	0.12
89		1897.227.49 thick strip (part of MS 47)	0.03	0.16	0.01	0.09	83.14	0.78	0.21	0.03	0.09	0.00	15.32	0.14
91		1897.218B.44 cauldron base	0.01	0.10	0.00	0.01	79.71	0.35	0.07	0.26	0.12	0.00	19.04	0.33

Appendix 7a

Middlebie hoard catalogue

no.	object	MacGregor	mm	g	metal alloy	image
FA 45	bridle bit ring	Vol 2 no.12	58	52.23	leaded bronze	
FA 46	bridle bit ring	Vol 2 no.12	58	51.94	leaded bronze	
FA 47	bridle bit ring	Vol 2 no.13	58	52.09	leaded bronze	
FA 48	bridle bit ring	Vol 2 no.13	58	50.82	leaded bronze	
FA 49	elongated strap union	Vol 2 no.33	98x24	49.88	leaded bronze	
FA 50	elongated strap union	Vol 2 no.34	98x24	51.78	leaded bronze	
FA 51	elongated strap union	Vol 2 no.35	76x24	28.04	leaded bronze	
FA 52	button & loop fastener	Vol 1 p132.2	47x25	17.08	bronze	

FA 53	button & loop fastener	Vol 1 p132.1	37x15	8.6	bronze	
FA 54	button & loop fastener	Vol 1 p132.1	38x16	8.66	leaded gunmetal	
FA 55	enamelled strap union	Vol 2 no.22	45x54	63.96	gunmetal	
FA 56	strap union	Vol 2 no.23	43x45	29.85	leaded bronze	
FA 57	hilt guard	Vol 2 no.149	49x20	47.09	leaded gunmetal	
FA 58	platform terret with saddle bar	Vol 2 no.72	78x62	85.54	leaded bronze	
FA 59	knobbed terret with saddle bar	Vol 2 no.88	86x66	97.14	leaded bronze	
FA 60	simple terret with straight bar	Vol 2 no.55	61x51	48.62	brass	
FA 61	simple terret with straight bar	Vol 2 no.56	55x47	49.76	bronze	

FA 62	knobbed terret with simple bar with rudimentary tang	Vol 2 no.89	63x54	36	leaded bronze	
FA 63	knobbed terret with tanged bar	Vol 2 no.90	53x49	34.1	leaded bronze	
FA 64	knobbed terret with tanged bar	Vol 2 no.91	53x49	36.1	bronze	
FA 65	knobbed terret with straight bar	Vol 2 no.92	59x48	36.1	leaded bronze	
FA 66	knobbed terret with straight bar	Vol 2 no.93	59x50	43.54	leaded bronze	
FA 67	simple terret probably with straight bar	Vol 2 no.57	53x40	36.79	bronze	
FA 68	simple terret originally with straight bar	Vol 2 no.58	44	7.57	leaded bronze	
FA 69	strap fastener	Vol 2 p136.1	20x36	14.9	leaded bronze	
FA 70	single link bit	Vol 2 no.11	193x59	221.09	ring (bent) = bronze; link = bronze; link end = leaded bronze;	
FA 71	derivative 3 link bit	Vol 2 no.5	61x25	222.57	ring (elaborate) = brass; ring (less	

Appendix 7b

Middlebie hoard metal analysis (XRF National Museums Scotland)

Object no.	object	part	Fe	Ni	Cu	Zn	As	Pb	Ag	Sn	Sb	total
FA 45	bridle-bit ring	ring	0.82	0.00	87.90	0.43	0.17	1.23	0.05	9.30	0.10	91.50
FA 46	bridlebit ring	ring	1.15	0.02	84.59	1.54	0.19	2.61	0.12	9.55	0.23	91.35
FA 47	bridlebit ring	ring	0.60	0.00	86.83	0.47	0.67	2.62	0.13	8.55	0.13	102.23
FA 48	bridlebit ring	ring	0.76	0.03	89.18	0.76	0.05	1.55	0.08	7.44	0.16	103.36
FA 49	elongated srap union	reverse	1.36	0.00	86.76	1.00	0.00	1.16	0.08	9.48	0.16	65.70
FA 50	elongated srap union	reverse	0.14	0.00	89.99	1.06	0.00	1.63	0.06	7.01	0.12	109.30
FA 51	elongated srap union	reverse	2.25	0.00	87.60	1.14	0.00	3.48	0.06	5.39	0.09	113.40
FA 52	strap fastener	reverse	1.25	0.01	83.86	0.16	0.30	0.53	0.12	13.38	0.40	98.90
FA 53	button & loop fastener	reverse	0.56	0.00	92.24	1.69	0.21	0.59	0.03	4.55	0.13	80.40
FA 54	button & loop fastener	reverse	1.41	0.01	87.50	4.52	0.00	2.07	0.05	4.34	0.10	118.95
FA 55	enamelled strap junction	reverse	0.51	0.00	85.53	9.50	0.25	0.53	0.06	3.40	0.21	94.40
FA 56	strap junction	reverse	1.06	0.01	88.51	0.38	0.00	1.23	0.20	8.15	0.46	87.99
FA 57	hilt guard	reverse	0.80	0.02	86.06	6.79	0.15	1.05	0.04	4.95	0.13	98.80
FA 58	platform terret	bar	0.44	0.00	88.41	0.41	0.00	2.15	0.10	8.31	0.20	104.02
FA 58	platform terret	ring	0.14	0.00	89.39	1.10	0.00	2.66	0.07	6.39	0.24	100.62
FA 59	knobbed terret	bar	0.30	0.00	83.24	0.61	0.00	7.39	0.08	8.29	0.09	101.80
FA 59	knobbed terret	ring	0.93	0.00	83.43	0.73	2.56	4.31	0.05	7.87	0.14	82.50
FA 60	simple terret	bar	0.36	0.00	91.78	4.58	1.99	0.26	0.01	0.98	0.04	100.83
FA 60	simple terret	bar	0.31	0.01	91.33	5.23	1.80	0.30	0.02	0.95	0.05	104.91
FA 60	simple terret	ring	0.66	0.00	90.01	7.59	0.26	0.27	0.02	1.16	0.04	102.10
FA 61	simple terret	bar	0.41	0.00	88.91	0.15	0.17	0.49	0.35	8.74	0.78	99.06
FA 61	simple terret	ring	0.50	0.00	86.10	0.18	0.33	0.51	0.51	10.74	1.13	93.63
FA 62	knobbed terret	ring	1.37	0.00	71.41	0.96	0.10	5.32	0.08	20.52	0.23	72.77
FA 62	knobbed terret	bar	0.92	0.00	77.59	0.58	0.00	3.30	0.08	17.37	0.15	82.65
FA 62	knobbed terret	ring	4.37	0.00	65.42	0.76	0.00	4.34	0.05	24.87	0.19	43.75
FA 63	knobbed terret	bar	0.36	0.00	87.26	0.38	1.13	4.23	0.12	6.38	0.15	109.50
FA 63	knobbed terret	ring	0.24	0.00	93.15	0.20	0.00	1.11	0.05	5.18	0.07	105.78
FA 64	knobbed terret	bar	0.42	0.00	76.31	0.24	0.68	0.39	0.23	20.73	1.01	84.46
FA 64	knobbed terret	ring	0.22	0.06	88.01	0.23	0.19	0.13	0.13	10.51	0.51	110.81
FA 65	knobbed terret	bar	0.58	0.00	88.10	0.63	0.52	1.01	0.09	8.99	0.09	106.37
FA 65	knobbed terret	ring	0.19	0.00	88.32	0.40	1.06	1.48	0.07	8.40	0.08	106.59
FA 66	knobbed terret	bar	0.61	0.00	92.17	0.28	0.35	2.09	0.04	4.36	0.10	103.78
FA 66	knobbed terret	ring	0.75	0.00	92.76	0.23	0.12	1.60	0.08	4.39	0.08	98.55
FA 67	simple terret	ring	0.07	0.51	84.86	0.14	0.17	0.54	0.11	13.06	0.54	104.08
FA 69	strap mount	reverse	2.73	0.00	82.09	0.44	0.18	1.52	0.08	12.85	0.12	63.20
FA 70	single link bridlebit	ring (bent)	1.03	0.00	87.51	1.14	0.63	0.29	0.07	9.17	0.16	89.20
FA 70	single link bridlebit	link	0.96	0.01	87.08	0.36	0.23	0.55	0.08	10.63	0.10	89.99
FA 70	single link bridlebit	link end	0.50	0.01	81.68	0.14	0.00	10.88	0.04	6.53	0.22	101.70
FA 70	single link bridlebit	riing (other)	1.31	0.03	88.86	2.84	0.19	0.42	0.09	6.02	0.24	107.50
FA 71	derivative 3-link bit	ring (elaborate)	0.66	0.01	88.56	8.05	0.45	0.41	0.03	1.71	0.12	105.30
FA 71	derivative 3-link bit	link	0.47	0.04	92.50	2.23	0.63	0.58	0.08	3.36	0.10	87.90
FA 71	derivative 3-link bit	link	0.33	0.00	91.89	2.80	0.38	1.16	0.05	3.26	0.11	114.80
FA 71	derivative 3-link bit	riing (other)	0.70	0.00	92.03	3.69	0.28	1.13	0.04	2.07	0.06	96.90
FA 71	derivative 3-link bit	ring (elaborate)	0.65	0.00	84.87	11.85	0.42	0.32	0.03	1.70	0.10	96.10
FA 68	simple terret		1.36	0.00	72.20	0.47	0.84	1.23	0.20	23.52	0.17	59.00

Appendix 8a

Late Iron Age and Early Romano-British copper alloy artefacts from Wales: metal analysis (SEM EDS/WDS)[6]

(Objects containing red glass or enamel)

Object	Provenance	Number	Fe	Co	Ni	Cu	Zn	As	Sn	Sb	Pb
ring	Tintern	2012.104.2	0.14	0.13	87.11	0.39	0.23	0.10	11.84	0.00	0.29
horse figurine	Gelli-onnen-isaf, Swansea	2005.176	0.71	0.00	0.04	86.30	2.43	0.32	12.03	0.00	0.83
toggle	Stroat, Gloucestershire	2006.14.1	0.07	0.00	0.00	90.48	0.25	0.27	5.77	0.40	0.92
toggle	Maescar	E005973	0.35	0.00	0.01	87.83	0.17	0.35	10.31	0.00	1.08
bell	Maescar	E005973	0.17	0.00	0.00	83.00	0.29	0.33	14.07	0.00	1.16
bowl	Langstone	6321	0.08	0.00	0.00	89.10	0.02	0.18	11.34	0.00	0.03
toggle	Felin Fach, Brecon	E013556	0.07	0.03	0.01	88.46	0.03	0.58	10.35	0.13	0.34
duck head	Nevern Haverfordwest	E001997	0.04	0.01	0.00	89.82	0.08	0.19	7.42	0.11	0.84
strap union	Alltwen	98.19H	0.19	0.01	0.09	87.50	0.00	0.30	11.30	0.22	0.22
tankard handle	Coelbren	2004.166	0.03	0.10	0.11	82.31	0.06	0.32	15.86	0.00	1.15
strap union	Maendy	2007.3H1	0.03	0.00	0.02	91.47	0.15	0.39	9.58	0.00	1.15
bell	Maendy	2007.3H1	0.29	0.00	0.00	95.55	0.05	0.26	6.12	0.00	0.50
terret dome 1	Pentyrch	65.821	0.20	n/a	0.00	87.10	0.00	0.00	11.60	0.00	0.00
terret dome 2	Pentyrch	65.821	1.00	n/a	0.00	85.40	0.00	0.00	12.70	0.00	0.00
terret dome 3	Pentyrch	65.821	0.02	n/a	0.15	89.09	0.02	0.37	8.99	0.49	0.15
terret	Pentyrch	65.821	0.10	n/a	0.00	87.55	0.00	0.00	11.16	0.00	0.00
bowl rivet	Snowdon	74.20H	0.02	0.00	0.00	89.71	0.00	0.22	8.55	0.29	0.32
bowl plate	Snowdon	74.20H	0.08	0.00	0.01	91.51	0.04	0.20	7.37	0.52	0.04
bowl attachment	Snowdon	74.20H	0.04	0.00	0.05	91.71	0.02	0.18	6.72	0.57	0.07
bowl	Snowdon	74.20H	0.05	0.00	0.08	86.69	0.01	0.16	11.02	0.89	0.20
pendant hook	Seven Sisters	04.136/1	0.03	0.00	0.01	89.03	0.08	0.24	9.96	0.00	0.93
pendant hook	Seven Sisters	04.137/1	0.05	0.00	0.04	88.00	0.07	0.13	12.90	0.00	0.08
tankard handle	Seven Sisters	04.140	0.27	0.00	0.00	86.94	0.00	0.00	12.23	0.30	0.10
tankard handle	Seven Sisters	04.141	0.10	0.01	0.07	87.49	0.01	0.07	11.84	0.17	0.10
mount	white castle	E000258	0.08	n/a	0.08	86.21	0.08	0.30	11.95	0.00	0.80
dome	Whitton	74.40H	0.04	n/a	0.09	87.23	0.06	0.41	11.47	0.00	1.20
tankard handle	Langstone	NMW	0.18	0.00	0.00	87.82	0.04	0.28	10.78	0.80	0.11
pin head	Dinorben	65.409.76	0.07	n/a	0.00	76.70	0.63	0.00	8.50	0.00	12.80
pin head	Dinorben	67.556.52	0.61	n/a	0.00	78.50	0.90	0.00	7.30	0.00	10.70
disc	Dinorben	65.73.12	0.19	n/a	0.00	77.80	0.88	0.00	9.60	0.00	3.50
brooch	Prestatyn	sf.437 3	0.00	n/a	0.00	76.68	19.96	0.00	2.31	0.00	0.21

[6] Black = EDS; red = WDS

Appendix 8b

Late Iron Age and Early Romano-British copper alloy artefacts from Wales: glass analysis (SEM EDS)

Object	Provenance	Number	Na2O	MgO	Al2O3	SiO2	P2O5	S02	Cl	K2O	CaO	TiO2	MnO	Fe2O3	CuO	ZnO	SnO2	Sb2O3	PbO
ring	Tintern	2012.104.2	10.02	0.60	1.47	43.12	0.25	0.00	0.35	0.54	4.07	0.10	0.64	0.86	4.53	0.00	0.40	1.21	31.64
horse figurine	Gelli-onnen-isaf, Swansea	2005.176	9.14	0.39	1.27	40.46	0.00	n/a	0.87	0.16	3.03	0.08	0.06	0.52	9.18	0.00	0.00	1.80	33.04
toggle	stroat, Gloucestershire	2006.14.1	10.77	0.38	1.36	40.65	0.00	n/a	0.92	0.14	2.48	0.11	0.07	0.53	10.61	0.00	0.00	1.60	30.38
toggle	Maescar	E005973	9.50	0.44	1.30	39.46	0.00	n/a	0.90	0.18	3.26	0.11	0.20	0.41	11.52	0.00	0.00	1.62	31.10
bowl escutcheon	Langstone	6321	12.65	1.55	2.72	56.61	1.11	0.31	0.67	2.53	9.20	0.22	0.53	1.31	3.56	0.00	0.26	0.67	6.07
toggle	Felin Fach, Brecon	E013556	9.28	0.53	2.07	44.93	0.15	0.02	0.64	0.39	4.49	0.07	0.03	0.75	7.60	0.00	0.34	1.94	26.79
semi-circular mount	Penllyn	E007913	8.65	0.55	1.98	42.80	0.09	0.00	0.70	0.36	3.49	0.16	0.00	0.80	6.36	0.00	0.02	1.21	32.82
mount	Carew Castle	E000671	8.82	0.65	1.52	41.71	0.00	n/a	0.71	0.36	3.24	0.13	0.62	0.59	8.35	0.00	0.52	1.33	32.21
duck head	Nevern Haverfordwest	E001997	8.61	0.40	1.46	40.53	0.00	n/a	0.70	0.28	3.92	0.03	0.23	0.56	7.03	0.00	0.00	2.03	34.23
strap union	Alltwen	98.19H	9.38	0.49	1.86	42.21	0.00	n/a	0.93	0.17	4.08	0.07	0.10	0.47	15.21	0.00	0.00	0.96	24.08
tankard handle	Coelbren	2004.166	9.70	0.41	1.40	44.00	0.00	n/a	0.78	0.40	4.61	0.11	0.34	0.51	9.26	0.00	0.00	1.15	27.33
strap union	Maendy	2007.3H1	9.08	0.41	1.63	40.64	0.00	n/a	0.52	0.38	4.64	0.05	0.32	0.86	4.46	0.00	0.00	1.60	35.41
terret dome 1	Pentyrch 13	65.821	9.53	0.48	1.45	41.20	0.00	n/a	0.70	0.37	4.43	0.05	0.40	0.61	7.40	0.00	0.00	1.90	31.50
terret dome 2	Pentyrch 15	65.821	9.57	0.52	1.47	41.07	0.00	n/a	0.56	0.37	4.40	0.03	0.37	0.61	8.59	0.00	0.00	1.37	31.07
terret dome 3	Pentyrch 17	65.821	9.81	0.54	1.85	42.55	0.00	n/a	0.62	0.40	4.54	0.02	0.19	0.60	10.41	0.00	0.00	1.67	26.79
terret	Pentyrch 19	65.821	9.08	0.46	1.46	41.47	0.00	n/a	0.58	0.32	4.93	0.02	0.39	0.55	5.36	0.00	0.00	2.16	33.21
cat escutcheon	Snowdon 10	74.20H	7.88	0.33	1.31	35.83	0.00	n/a	0.76	0.16	3.83	0.09	0.18	1.18	7.78	0.00	0.00	0.00	40.68
cat escutcheon	Snowdon 9	74.20H	7.89	0.30	1.37	35.68	0.00	n/a	0.71	0.17	3.75	0.10	0.15	1.24	8.32	0.00	0.00	0.02	40.29
pendant hook	Seven Sisters	04.136/1	11.48	0.34	1.53	44.18	0.30	n/a	0.90	nd	3.85	0.23	0.23	0.47	8.49	0.23	0.23	1.99	31.92
pendant hook	Seven Sisters	04.137/1	10.02	0.31	1.47	43.67	0.22	n/a	0.90	0.00	3.65	0.00	0.17	0.50	9.90	0.00	0.25	1.67	31.79
tankard handle	Seven Sisters	04.140	11.15	0.42	1.58	43.43	0.36	0.37	0.79	0.48	4.07	0.10	0.34	0.55	9.40	0.00	0.00	1.26	25.71
tankard handle	Seven Sisters	04,141	10.17	0.39	1.52	43.25	0.33	0.25	0.74	0.39	4.19	0.04	0.24	0.47	10.41	0.00	0.00	1.07	26.53
mount	white castle	E000258	9.42	0.52	1.63	42.53	0.00	n/a	0.71	0.45	4.59	0.10	0.44	0.50	11.49	0.00	0.00	1.50	26.10
dome	Whitton 11	74.40H	12.96	0.53	1.88	42.00	0.00	n/a	0.73	0.34	3.69	0.06	0.28	0.49	9.21	0.00	0.00	1.18	26.65
dome	Whitton 12	74.40H	10.57	0.54	1.63	43.78	0.00	n/a	0.68	0.42	4.49	0.02	0.32	0.51	9.62	0.00	0.00	1.25	26.17
round disc	Penllyn	86.26H/8	14.44	2.29	2.88	53.53	0.97	n/a	1.16	1.28	8.48	0.30	0.64	2.19	2.40	0.00	0.00	0.17	9.27
collar	Boverton	NMW	12.98	2.40	2.55	54.67	1.20	n/a	1.11	1.95	8.26	0.22	0.52	2.56	2.41	0.17	0.00	0.00	9.00
collar	Boverton	NMW	13.11	2.50	2.45	54.42	1.20	n/a	1.14	2.08	8.38	0.27	0.56	2.49	2.17	0.16	0.00	0.31	8.76
collar	Boverton	NMW	12.68	2.80	2.57	53.98	1.38	n/a	1.23	2.03	8.34	0.26	0.54	2.52	2.15	0.00	0.00	0.30	9.20
disc	Dinorben	65.73/12	15.31	1.21	2.51	57.92	0.49	n/a	1.02	1.45	6.30	0.14	0.63	2.69	2.29	0.00	0.00	0.22	7.83
pin head	Dinorben	65.407.14	18.70	nd	2.42	69.37	n/a	0.28	0.96	0.60	6.21	n/a	nd	0.62	1.98	n/a	0.00	0.00	1.10
pin head	Dinorben	65.409.76	15.70	nd	3.26	59.53	n/a	0.35	0.79	0.66	6.20	n/a	nd	2.20	1.21	n/a	0.00	0.00	10.58
pin head	Dinorben	67.556.52	11.97	nd	1.76	58.87	n/a	0.67	0.76	2.73	9.52	n/a	nd	1.39	1.74	n/a	0.00	0.00	8.89
disc	Dinorben	65.73.12	15.31	1.21	2.51	57.92	0.49	0.37	1.02	1.45	6.30	0.14	0.63	2.69	2.29	0.00	0.00	0.22	7.83
brooch	Biglis	97.29H/1	7.63	1.38	1.37	33.32	1.01	0.00	0.83	0.80	4.44	0.17	0.27	1.43	7.02	0.00	0.00	0.17	40.15
brooch	Prestatyn	sf.437 3	7.30	0.20	1.00	44.40	n/a	0.30	0.70	0.30	2.90	n/a	nd	0.20	7.20	n/a	0.60	1.80	34.80
square terret	Brecon Gaer	PAS	10.44	1.19	1.20	38.17	0.95	n/a	0.92	1.17	3.82	0.09	0.25	2.36	8.46	0.00	0.56	0.76	29.70
round terret	Brecon Gaer	PAS	11.16	0.57	1.52	40.22	0.54	n/a	0.80	0.38	3.26	0.10	0.28	0.74	8.16	0.00	0.10	0.35	31.92
mount	Brecon Gaer	7652	10.98	1.32	3.35	38.92	0.83	n/a	0.99	0.64	6.76	0.30	0.25	4.11	6.78	0.39	0.74	0.23	23.43
brooch	orcop	PAS	9.41	0.58	1.73	33.66	0.78	n/a	1.09	0.45	4.01	0.14	0.14	0.79	5.28	0.07	0.19	0.40	41.34

Appendix 9

Horse equipment

It seems reasonable to deduce that horses or ponies and many of their accoutrements were for display as much as for use, and this conclusion can be inferred from the materials and manufacture of some of the extant harness equipment. The use of bronze coatings on iron for many earlier pieces, such as those from sites as diverse as Kirkburn, Ringstead and Lyn Cerrig Bach etc (Macdonald 2007 57-60) or of bronze itself for the vast majority of surviving horse bits and terrets from Britain, point to the importance of appearance as much as use. However, the bias of the surviving material could also be skewing the picture significantly; for example, many bits found away from hoarding contexts such as on hillforts or settlements tend to be predominantly of iron, which survives less well (e.g. Ham Hill or Hunsbury (Macdonald 2007, 57-60); (though many still have some bronze components). Functionality in association with time and place probably lent differing connotations for those using the equipment.

'With the exception of bridle-bits (which themselves did not need to be made of metal) metal fitments acted either as junction objects or as decorations. They were of no consequence in controlling ponies but instead aided the effectiveness of the functioning harness systems and facilitated the good fit of harness and its removal' (Palk 1991, 813). The majority of the harness was made from organic materials, and there is little surviving material evidence for this.

The use of the majority of metal fittings on harness equipment was therefore not a necessity; however, they did allow for more versatile adjustment of the harness straps, possibly enabling horses to be fitted more quickly, and allowing easier adjustments to be made for different sized ponies, but 'such fittings were not indispensible for the proper action of harness; if for example, there was no supply of metal strap unions, a temporary join could be made of leather thong or rope' (Palk 1991, 813).

Palk's remarks are important when looking at the development of metal horse harness equipment, and the elaborate style and decoration employed for a large number of pieces, especially on Insular La Tène artefacts dating to the later Iron Age. It emphasises the status afforded to horses and chariots, and their use as a means of displaying this; it also emphasises the importance or significance of copper alloys in relation to iron in these contexts. Iron would be functional, easier to obtain for many sectors of the population, and certainly easier to repair and re-use than the majority of bronze harness equipment; and iron was not substituted by copper alloys on the continent where it remained the main metal used for such objects (Palk 1984) . 'Despite Northover's suggestion that at the end of the first millennium BC bronze was in surplus for the first time (1984 142), it would appear that, nevertheless, prestige continued to be attached to bronze objects' (Palk 1991 328). The display of bronze for such artefacts was probably a tradition carried through from when there was a relative scarcity. The practice of coating iron - done in several different ways (applied sheeting, brazing, dipping, tinning then dipping etc) involved skill and technology in manipulating a scarce resource, which appearances seemed to require. There are many examples where iron bits were coated with bronze, e.g. Kings barrow (Fox 1958, 7); Gussage All saints (Spratling 1979, 129); Maiden Castle (Northover 1991, 161), Llyn Cerrig Bach (MacDonald 2007), (Laidlaw 2003; Palk 1984), and also examples of bronze coated iron terrets (Palk 1991, 297). In addition to this, there are examples where terrets, toggles and bridle-bit rings were not formed from solid metal, but partially filled with a core of clay/silt like material, which saved on the use of bronze, but would have left the metal fittings intrinsically weaker

There are many detailed descriptions of horse equipment, plus various typologies and interpretations, such as those written by Leeds (1933), Fox (1946 and 1958), MacGregor (1976), Palk (1984 and 1991), Spratling (1972) and Macdonald (2007). There are also concurrent studies such as the work on terrets by Anna Lewis (University of Leicester). The following does not summarise these in detail, but points out some features which help interpret manufacture, use and change of particular types of horse pieces. One problem with developing such typologies is that despite many common features in later Iron Age artefact types and designs, there is much regional diversity within Britain in both time and space; this is coupled with the fact that many of these items are unique, and made to be so. This is not just apparent by the technology used in most cases(i.e. *cire perdue* for copper alloy objects), but also by the individualisation of so many similar artefacts, as exemplified by the variation amongst similar objects within Late Iron Age hoards such as Polden Hill (chapter 6). As Garrow and Gosden state 'the material we know as Celtic art does not generally change in an easily understood typological manner'(Garrow and Gosden 2012, 17), and this 'is due to an emphasis on variety and difference on the part of the metalworkers of the later Iron Age and not a function of small sample sizes or taphonomy' (ibid).

Materials, decoration

On the continent, from Early La Tène onwards, the majority of Iron Age bridle bits were made of iron; this is in direct contrast to the surviving evidence for Britain (Palk 1984, 103). Here, there is a larger variation and combination of materials used, often combining bronze and iron for the manufacture of three link bridle-bits (chronologically earlier) (Palk 1984; Garrow *et al.* 2009), and using the qualities of the different metals, plus their strength and appearance to form practical working objects while exhibiting the bronze components to the maximum. These bits are likely to have been produced in a period when it may have been difficult to access bronze in the quantities desired (Palk 1984, 103). For other types of British Iron Age bridle-bits (predominantly two-link or three-link derivative bits dating to the late 1st century BC and 1st century AD (Palk 1984)), copper alloys were becoming easier to obtain and were predominantly used for all the components.

Palk notes that the part of the bit most likely to wear was the joining sections where metal would rub against metal; these pieces were always made of solid metal and predominantly of iron for the earlier more variable three-link examples (Palk 1984, 4). Sometimes they were cast in bronze or coated or plated, but did not use hollow bronze - as was the case for some of the rings. It is also notable that all the examples of the three-link bits cited by Palk which were not made entirely from iron, all had rings which would have appeared bronze.

The more sparing use of bronze can also be seen on other parts of harness equipment, where cast bronze ornaments were the norm, rather than sheathed iron components. Sometimes, either hollow castings, or partially hollow castings retaining some of the silt-like clay core were produced. Examples from Ferry Fryston (O'Connor 2009), which appear to have been hollow circular bronze fittings filled with wax and silt, and Hunsbury (Barnes 1985) have been documented, Palk (1991) also mentions massive terrets with clay cores (Palk 1991, 53), and it has been noted that several toggles have largely hollow interiors (noted by X-radiography; or by examination of broken or worn pieces. This has been observed on, amongst other objects, a terret ring from Middlebie, and 'toggles' from

Stroat and Polden Hill (figure A9.3; A9.4). This would have left the metal fittings intrinsically weaker (O'Connor 2009; Barnes 1985; Palk 1991, 53). Analyses on examples of this core material show it also contained wax (O'Connor 2009), which was integral to the casting process. All this points to appearance as much as function; it adds weight to the symbolic rather than functional use and display of horses and chariots for many of the copper alloy items surviving, especially from hoards; in serious combat a charioteer could not risk using weakened or inappropriate pieces of equipment.

As Jope states: 'If, as seems likely in the Late Iron Age, the use of chariots become even more for display than use, it can be argued that the same was happening with some of the associated metalwork. ... some items destined for burial in graves were old or possibly of limited use, and there is possible evidence that pieces created in the Late Iron Age were more for display than function' (Jope 2000, 152).

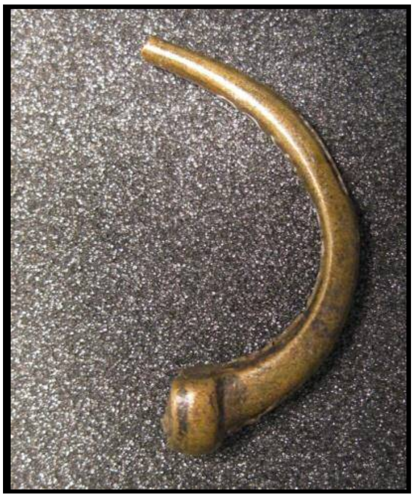



Figure A9.1: Bridle bit rings from the Middlebie Hoard (FA 67 and FA 68). Extensive use wear can be seen, despite the 'hollow' areas of the bit.

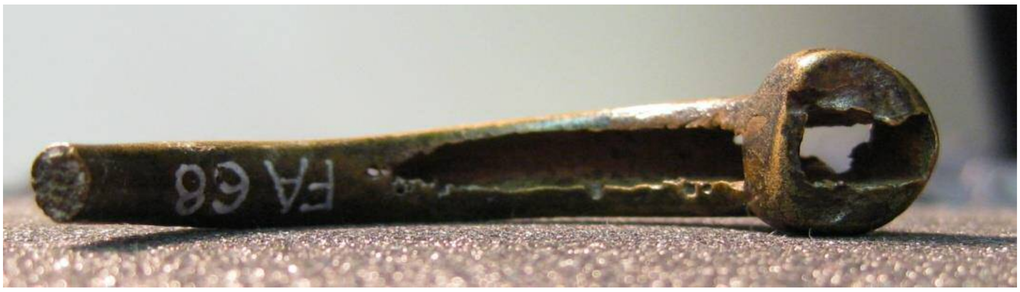


Figure A9.2: Middlebie (FA 68) broken fragment of bridle-bit ring showing how the end (largest volume) was not cast with solid bronze.

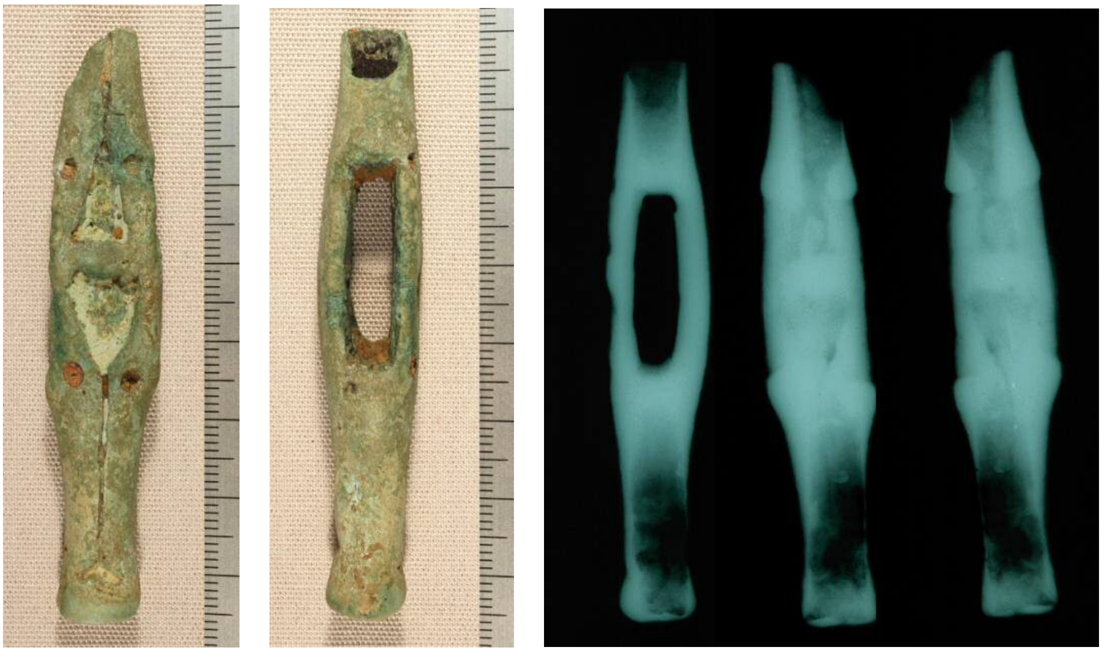


Figure A9.3: Toggle from Stroat in Gloucestershire (PAS 2006.14.4); the broken end and the X-ray illustrate the 'hollow' or 'silt/wax core' of a significant proportion of the toggle, though not in the area bearing the most strain

Bridle-bits

Bridle-bits are the only essential piece of harness necessary for the control of the horse; (Palk 1991, 118); they often appear to have been made in pairs for driving ponies (Spratling 1979, 138). Their decoration and deposition implies they contain a ritualistic and artistic aspect as well as a functional one.

Three-link bridle-bits: (also referred to as 'double-jointed snaffles')

These bits are made of five components and consist of two side rings, plus two side links and a central link. The earliest examples possibly date from the 4th or 3rd century BC; but the majority appear to date from the 1st century BC (Macdonald 2007, 72). Three-link bits could be made completely of bronze or of iron, or of a combination of both materials; in such cases, iron is mostly used for the side rings which are often coated with bronze, but many also had iron links (Spratling 1972, 86; Palk 1984, 3). For bronze links, the mould fragments from Gussage All Saints (Macdonald 2007, 65; Spratling 1979, 138; Foster 1980, 13) suggest these were manufactured in two stages: side links were separately cast by the lost wax method, and then joined by the *in situ* casting of the centre link, which was moulded round the two side links in wax and made into an investment mould. This allowed movement between the three bronze pieces, and would have required considerable skill to achieve.

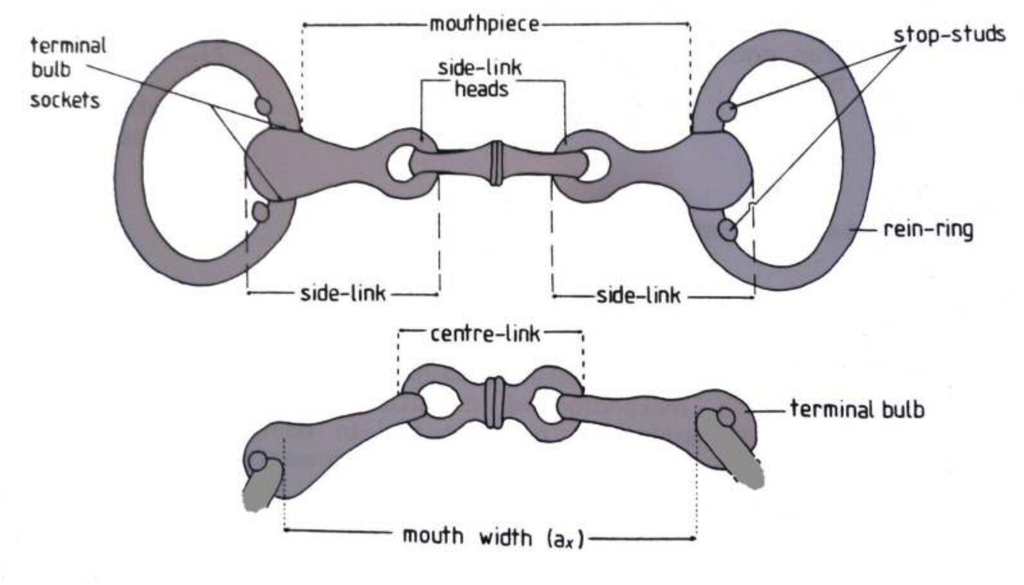


Figure A9.4: Components of a three-link bridle-bit (after Palk 1984, 3)

Three-link bits, as with terrets, do not appear to be continentally influenced; but patterns relating to the geographical distribution of these types of bridle-bit within Britain are not very clear. Previous attempts by Fox (1947), Spratling (1972) and Palk (1984) amongst others, to categorise by distribution or style are problematic. For example, Palk's categorisation by metal types for components leaves a complicated picture, and she states that 'by whatever convention the bits are arranged, there are always some morphological traits which a member or members of a group have in common with those of one or more other groups. The nature of these traits would tend to suggest that the bits are individual expressions of a common tradition, or at least they stem from a common origin, explaining why (except paired bits) the bits lack standardisation of shape' (Palk 1984, 61).

Although three-link bits are chronologically earlier than the two-link or three-link derivative types discussed below, and do not occur within the Late Iron Age hoard material studied here; they have several features which relate to the development of later pieces. The use of stop studs in three-link bits are associated with the technology for keeping the rein rings in place where these are not continuous; but they also had an effect on how the bit worked with the horse. A butt-join was inherent in the forging of an iron ring, and some of the side-rings , whether part bronze or part-iron 'were provided with stops set close to the butt-join on either side of the head of the link to prevent the rings from swivelling round' (Spratling 1972, 86). However, sometimes, for example when the ends of a tightly fitted iron ring are brazed together when dipped in bronze (Macdonald 2007, 66), or when the side-links were cast on to the side rings, this obviated the need for stops, but they were still retained on most of the bits (Spratling 1972, 87). The design and appearance of stop-studs, though not their function, seems to be echoed in some of the later three-link derivative bits.

When in use, three-link bits are thought to be less harsh than the two link bits on the horse's or pony's mouth, as 'nowadays, three-link bridle-bits are used for more tender mouthed equines, since the additional link reduces the nutcracker action of the mouthpiece when the reins are pulled in and this minimises the danger of pinching the tongue' (Spratling 1972, 101). However, the stops which prevented the rein rings from moving freely within the link would pressurise the horse's head through the reins, which themselves would be less free to move; so although two-link bits are considered harsher, their cast moveable rein ring would have counteracted this difference to some extent (Moi Watson pers. comm.).

Another important feature of three-link bits, which is picked up particularly in regard to the three-link derivative bits, is the use of different metals for appearance as well as function which is discussed above. For the earlier bits, iron and bronze were used, but for many of the three-link derivative bits, various types of copper alloy were incorporated. In both cases this could be to do with properties associated with the manufacture and wear of the metals, the horse/pony's reaction to different 'tasting' metals, of varying hardness in the mouth and to the impression formed by the type and colour of metal or decoration on the visible element of the bridle-bit: i.e. the rings.

Palk makes several interesting observations regarding three-link bridle-bits; one is that all those with bronze-plating on iron mouth pieces come from settlement sites. Related to this is the observation that all bits with solid cast bronze mouthpieces – i.e. those parts requiring most metal and skill for their manufacture, nearly all come from depositional contexts – as hoards, watery deposits or burials. She does not reason that these were made for deposition, as many are worn, but infers they were 'for best', whereas those with iron or bronze plated iron mouthpieces were more for everyday use (Palk 1984 67). This factor is also echoed by the fact that only the bronze bridle-bits are decorated (Palk 1984 67). This depositional practice is in contrast to the manufacturing evidence from moulds for decorated harness equipment found at Gussage All Saints (Foster 1980), Weelsby Avenue (Foster 1995) and South Cadbury (Spratling 1978, 138; Palk 1984, 67, Macdonald 2007, 65); the moulds were for making bronze items, but the sites were settlement sites.

A further point of interest in three-link bridle-bits is derived from the analysis of material from the Arras type burials in Yorkshire (Dungworth 1996 414-5). Dungworth analysed the components (side-links and centre links only) of five bridle-bits, including two from the Lady's Barrow at Arras (Stead 1979, figure 16); one from the King's barrow at Arras (Stead 1979, figure 15.1), and a further two from Kirkburn (Stead 1991, figure 44). For the Arras pieces the side-links in all three were cast from bronze, whereas the centre-links were a leaded bronze containing 4.68%; 2.18% and 1.13% of lead respectively. Only the side-links from the Kirkburn examples were analysed; but these also contained lead, at levels of 3.45% and 1.51% for one, and 2.65% and 2.53% for the second.

Unlike the vast majority of two-link bridle-bits such as those from Polden Hill, the use of leaded bronze for complex casting procedures seems to have been deliberately adopted and used for the three-link pieces. Even for the later three-link derivative bridle-bits, which mostly appear to incorporate different metal alloys for the various components within each bit, gunmetals rather than leaded alloys are used. The use of leaded bronze at this period is relatively rare; the only other pieces from these burials in which Dungworth detected more than two percent lead were in the top of a linch pin from Arras (2.09%), and a tubular cast ring from Garton Slack (4.05%) (Dungworth 1996, 414-5).The limited use of lead here is important in signalling the fact that alloying with lead was used and understood; but also how strongly it was avoided for most of the earlier Iron Age artefacts derived from significant burials or hoards.

Three link bits tend to be associated more strongly with other chariot parts such as tyres and nave hoops, whereas the subsequent types, are found more in association with other horse harness fittings, especially bronze pieces.

Two link bridle-bits: (also referred to as 'single-jointed snaffles')
This type of bit has four parts; two rein rings and two links. The vast majority are made from cast bronze, and they mostly occur in pairs. The rings are all circular with a circular section (Palk 1984, 13), and the two links are usually the same, attached at right angles to one another. The 'wing' or 'ring carrier' often has a distinctive mouth. Stylistically 'The ring-carrier of each link, except those from Llyn Cerrig Bach and Lydney, is modelled like a pair of ears, and is thus very similar to the wings on Group VI terrets , and on some of the escutcheons on bowls of Rose Ash form" (Spratling 1972, 99).

Contextual evidence seems to points to a mid first century AD date for the majority of these bits. Macgregor thinks they can be seen as the relatives and more uniform forerunners to a range of Romano-British two-link bits, predominantly made of iron, which were the norm from the mid first to fourth century AD (MacGregor 1976, I. 30-31). Spratling notes that 'since the two-link bit was the standard form on the continent during the pre-Roman Iron Age as well as later, it is curious that it should not also have been the standard type in Britain during the same period... it only appears to have come into fashion at the end of the period' (Spratling 1972, 101). It could therefore be argued that the introduction of this type of bridle-bit was relatively strongly influenced by continental contacts and the Roman invasions.

The majority of two-link bits (sixteen) come from the Polden Hill Hoard, but those from other provenances also have a mainly western and southern geographical bias (the most northerly occurring at Llyn Cerrig Bach on Anglesey), with only two out of twenty four of Palk's 1984 catalogue occurring elsewhere, both in Suffolk (Palk 1984, 13). The large majority of these bits have been found in pairs, and they also tend to be smaller than the preceding three-link bits; it is from these bits that the standard imagery of the Iron Age chariot pulled by a pair of relatively small ponies is derived.

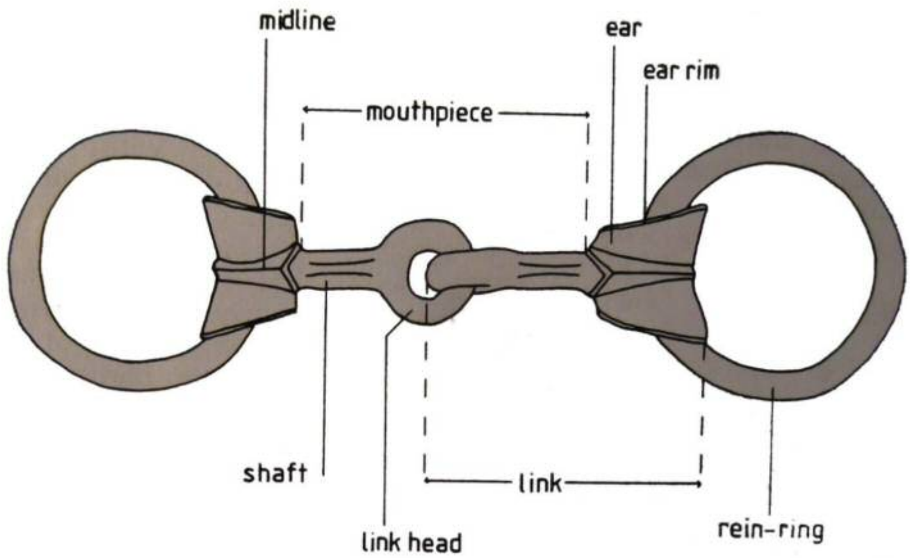


Figure A9.5: Components of a two-link bridle-bit (after Palk 1984, 14).

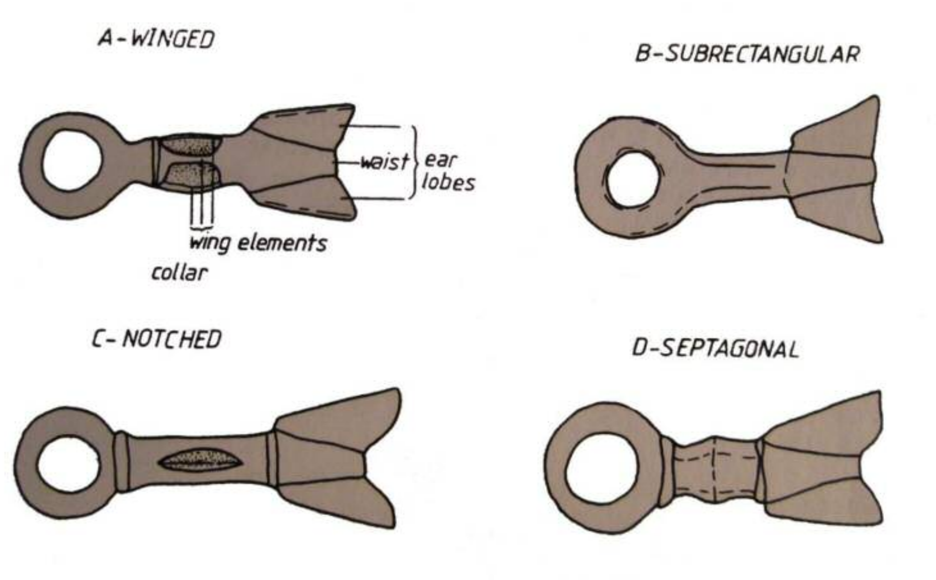


Figure A9.6: Side-links of Polden Hill type two-link bridle-bits (after Palk 1984, 14).

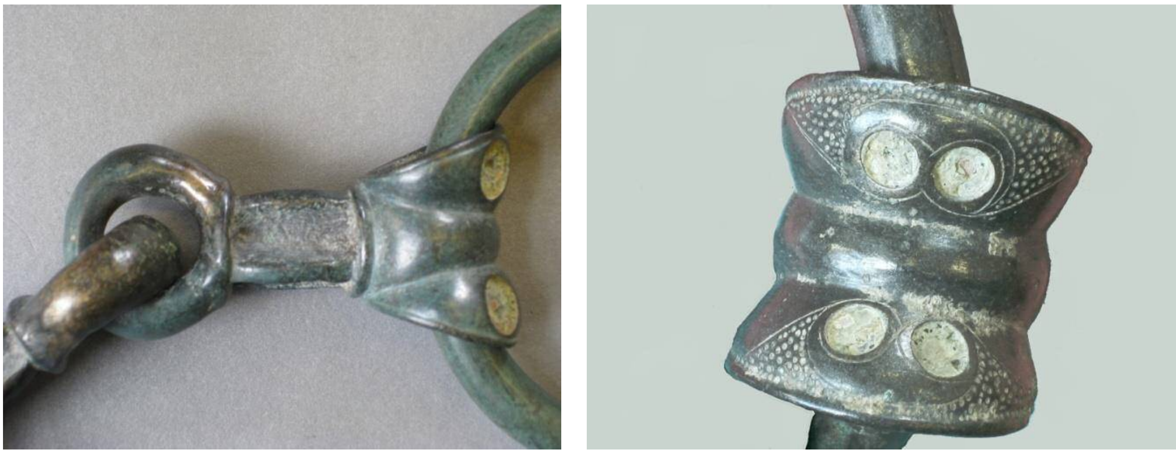


Figure A9.7: Detail of link on Polden Hill 46.3-22 70, and applied decoration on the ring carrier of 46.3-22 69.

The pairs within the Polden Hill Hoard are distinguished predominantly by their cast link pieces. These are all different, and there is some argument that they were made to fit to an individual pony's requirements. A bit in terms of size, is akin to having the correct shoe size, so they could be used by similarly sized animals, but it is also noticeable that the shapes on the shaft of the link vary considerably. Different types of shaft are thought to relate directly to the harshness of the bit in the mouth, and therefore the amount of control exerted over the pony 'the variety seen in the latter group is of great interest, since it suggests individual modelling for different customers' (Spratling 1972 99). The counter to this argument is that the links are the same within each pair, implying the shape was more the choice of the driver than for the sensitivity of an individual animal. Another characteristic of these bits is their elaboration by decoration, using complex cast shapes, but also often incorporating red inlays and scribed designs. For the Polden Hill examples, the inlaying and scribing has been applied after the object was cast, so seems to represent a further step towards 'individualisation' of the different pairs. Where these bits have been decorated further, this only occurs on the moulded 'wings' and is done predominantly by drilling circles into the metal, (though occasionally these are further embellished with lines and dots); this part of the bridle bit is where there is a maximum surface area to embellish without interfering with the function of the bit.

Palk observed that two-link bits appeared less worn than either the three-link or the three-link derivative bits, and that none of them were worn through. She thinks this is in part due to the 'very thick, bulbous link-heads which could stand a large amount of wear'. She also notes that 'the joints themselves are very closely cast, so that the amount of play between the link-heads would be relatively small, so reducing the amount of friction at the joint' (Palk 1984, 91). As with the three-link bits, a great deal of skill would have been required to cast the individual components to one another using the lost wax technique.

Three link derivative bridle-bits: (also referred to as 'straight-bar snaffles')

This type of bit has three components, a central link and two rein rings which are integral to the shaft of the side-link. The makes the ring appear as a fusion between the side-link and the ring as seen on the earlier three-link Iron Age bits, from which Palk thinks these were directly derived; even though the mouth piece consists of only one straight element. The side-rings are plano-convex in section rather than fully rounded, and are different from one another, a circumstance that led Leeds to infer (Leeds 1933, 115) that the bits were made in pairs, 'the more elaborately ornamented ring of each bit being intended to be seen on the outer sides of a pair of chariot ponies' (Spratling 1972, 94). Palk, in her analysis of similar bits disputes this 'none of the bits is paired, and they exhibit a high degree of variation in their morphology and in the decoration of their rein ring' (Palk 1984, 17).

It is also most impossible to say whether most Iron Age bits were produced as pairs or not; the only substantial number of verifiable pairs are the two-link forms from the Polden Hill hoard. There are many ways in which such evidence could be distorted: for example, it may have been a more common and acceptable practice to deposit a single part of a pair; or identical bits for a pair of horses might have been highly unusual. Although lacking paired examples of bridle-bits, the harness 'sets' from both Stanwick/Melsonby and Seven Sisters contain terrets, implying the use of a pulled vehicle.

The distribution of three-link derivative bits is predominantly from northern England and southern Scotland, with a large presence in the Stanwick/Melsonby hoard; but there are also notable examples further south in the Soham Toney and the Seven Sisters hoards (Macgregor 1962; Davies and Spratling 1976; Savoury 1976, 62, 109; Palk 1984, 53). Single finds or fragments are also known from Leicester and Wiltshire, and there is a burnt example from the cremation at Folly Lane (Niblett 1999). A list of known bits can be found on *The Celtic Art database*

The Folly Lane cremation burial is dated to AD 55 (Niblett 1999); however, hoards containing this type of bridle-bit cannot all be so closely dated, and, as MacGregor points out, 'their respective political backgrounds offer more of a clue' (MacGregor 1976, I. 25). Those found in hoards can all be associated with resistance to Roman occupation in the middle to late first century AD. MacGregor concludes her discussion on derivative three-link bridle-bits by stating, 'It is difficult not to interpret finds from Icenian, Silurian and Brigantian territories as visual proof of the complex political machinations which must have accompanied the spread of Roman rule in a reluctant Britain' (MacGregor 1976, I. 30).

Both two link and three link derivative bridle-bits are not found in as many types of sites as the three- link bits, and are mainly from non-settlement contexts. This could be to do with both their ceremonial use and or the fact that they were buried in hoards at a time of major upheaval during the Romanisation of Britain, especially in areas of relative resistance.

The asymmetry of the majority of the rings, the fact that some of the bits have flat backs, and that these bits were relatively small in size, resulted in Jope suggesting an ornamental rather than practical use for these bits. 'Towards the mid first century A.D. horse bit rings and even the whole bit came to be treated more as a modelled openwork composition, encouraged perhaps by an increasing tendency to see the bits hung up, stored for use, or even as trophies, for some bits were evidently non-functional, cast with solid dummy unswivelling joints or otherwise unusable except to hang up' (Jope 2000, 152).

Jope (2000, 152) uses the bridle bit from Rise as an example of this; another example is the bit from Middlebie, where their reverse side of the bit rings (FA 71) are flat and less finished on the underside (chapter 9). However, Macgregor dismisses Jope's argument on account of their wear, stress and fractures (MacGregor 1976, I. 25); e.g. figure A9.10; A9.11.

The type of lost wax casting which leaves a plain flat underside on the three-link derivative bridle-bits, appears to have been used for several other types of horse gear in the first century AD, especially strap-unions and button and loop fasteners. Although many of these objects are elaborately moulded or decorated on one face, their manufacture implies that the craftsman was very much concentrating on the outer face, presumably to save time and make the casting process less liable to fail. The backs of the objects often look largely unworked, as if after carefully shaping the wax model for the front, the back was merely flattened and encased by a plain clay slab to complete the investment mould, and was perceived as an adequate technique for shaping the reverse of the object.

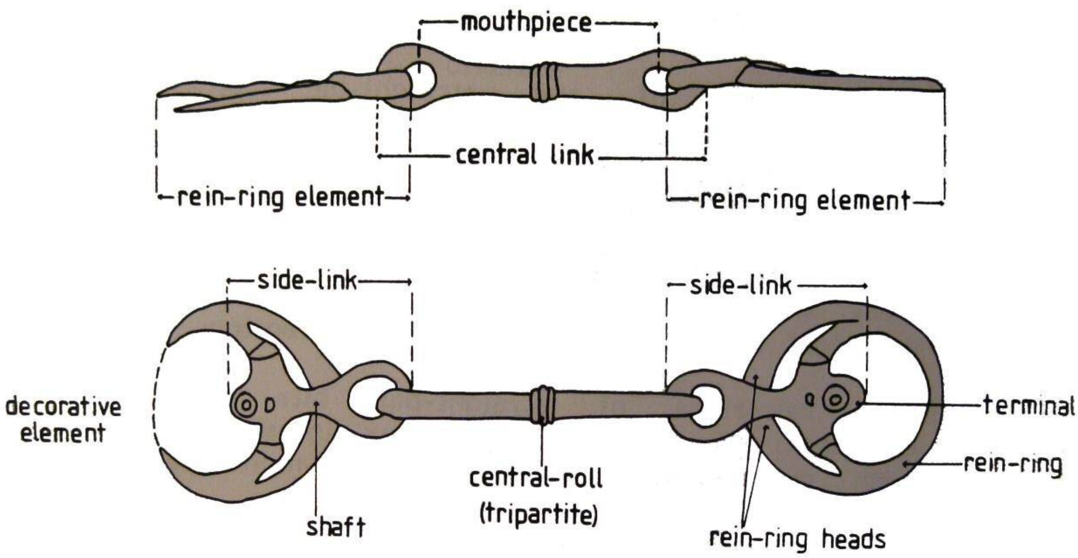


Figure A9.8: Components of a three-link derivative bridle-bit (after Palk 1984, 17).

Figure A9.9: The three link derivitive bridle-bit from the Middlebie hoard (FA71).

Figure A9.10: Bridle bit from the Middlebie Hoard (FA 71). The reverse of bridle bit shows the two dimensional nature of the moulding and decoration of this object. Use wear is also very evident.

In contrast to earlier bits, decoration on later decorated derivative three-link bits from sites such as Swanton Morley (Davies 2009, 12) Seven Sisters (Davies and Spratling 1976), Middlebie and Rise (Macgregor 1976; Jope 2000) etc, use much less pronounced three-dimensional modelling of the bit, but the decoration itself is often more elaborate and made prominent by being placed on the 'outer' surface of the ring.

There are mostly two strands of decoration used on these bits: one is purely through its cast form, the other contains polychrome enamel. Analytical work by Northover (1999), Dungworth (1996) and this study show that the type of metal used is closely allied to this type of bit, and to the type of decoration incorporated. The majority of three-link derivative bits are brass, and tend to use a purer, higher zinc content brass for the components that would have been visible when worn, i.e. the rings. Inlaid decoration, when used, is in contrast to the bronze two-link bits, and uses polychrome enamel or glass; the sealing wax red glass, associated with so much Late La Tène art of the first century AD seems reserved for bronze objects (chapter 5). MacGregor is misled about the use of red glass on the Seven Sisters piece, which is decorated with polychrome enamel into geometric cells. She is also likely to be incorrect regarding its use on the horse gear from Stanwick (Melsonby); here a more detailed look at the literary evidence (MacGregor 1962; Dungworth 1997) indicates that red glass was only inlaid into 'set D' for which the metal was predominantly bronze rather than brass (Dungworth 1996).

The Folly Lane bridle bit, probably relatively early in date, is interesting; like the others it has a relatively high zinc brass for the rings, but a gunmetal for the bar. It also has polychrome decoration, but the recesses look crudely cut and appear to be inlaid with small fragments of glass rather than enamel (unlike the Seven Sisters and Rise bits) (Northover 1999, 180). As he states in relation to the gunmetal composition of the Folly Lane bar 'The centre link, not designed to be seen, will be duller in appearance but the alloy will give better casting properties and wear and, perhaps, corrosion resistance. The choice should be seen as deliberate, suggesting that the craftsman could differentiate between a number of different compositions intermediate between bronze and brass' (Northover 1999, 137).

Northover's analysis (1999, 137)of the Folly Lane bridle-bit correlates well with results for other three-link derivative bits, especially where both the side-link/ring component and the central bar have been examined. Dungworth (1996, 414-421) analysed separate components from the three-link derivative bridle-bits from Rise and Place Fell, plus one from the Stanwick/Melsonby hoard. For Rise, both the side-links/rings were brass, and the centre bar bronze; for Place Fell, the centre bar (which would not be visible) was tin bronze; one side link/ring was bronze with some zinc, and the other side-link/ring was brass. The bridle-bit from Stanwick/Melsonby 'set A' (Macgregor 1962, 43-44 no. 37), also had a side-link /ring of brass and a central bar of bronze; (the other central bar analysed by Dungwoth (1996, 419) is from a bronze style bridle-bit from 'set D' ((Macgregor 1962, 43, 45 no.47), and has the same metal type as the ring). The bridle-bit from Middlebie is similar, a brass side-link with ring, and a gunmetal central bar (appendix 7b). It is worth remembering that a tradition of using the 'correct' colour of material had been practised extensively when coating or brazing iron components, especially rings, for the chronologically earlier three-link bridle-bits.

All the main groups of bridle-bits show degrees of wear, but the three-link derivative types are by far the most worn examples, and unlike other bits this is evident on the rein rings. Palk believes this degree of wear could not have been caused by leather rubbing on the bronze, so believes that 'either the reins or the cheek-straps (or both) were joined to the rein-rings by some form of metal fastener'. She also reasons, more convincingly, that because of their flattened reverse, and the decoration on the terminals, the derivative three-link bits could only have been worn one way round, and thereby the same areas were continually subjected to considerable wear (Palk 1984, 90); this occurs mostly at link joints and to some extent at the rein-ring sockets; its likely cause is friction between metal surfaces.

Other Horse Gear

There are several other types of horse gear present in the hoards; sometimes their precise function is unclear, but they have been grouped as horse harness equipment by their context and association.

‘Pendant hooks’ or ‘rein hooks’

Figure A9.11: ‘Pendant hooks’ from the Seven Sisters hoard (04.136-7).

Similar objects described as ‘pendant’ or ‘rein’ hooks are found in both the Seven Sisters and the Polden Hill Hoards. ‘Each...is flat at the back and has a rectangular loop projecting from one of the terminals; on Polden Hill the loop projects from the ends, while on Seven Sisters they project from the back. The objects were doubtless suspended from these loops’ (Spratling 1972, 102).

Figure A9.12: ‘Pendant hooks’ from Polden Hill (1846.3-22 108).

Spratling (Spratling 1972, 102) thinks the pendant hook pairs are closely matched by pairs of rein-hooks suspended from the ends of the cheek pieces, which were used in place of the snaffle-rings found on other kinds of bit, very similar to the modern 'curb-bit'. He compares the similarity in appearance of the hooks with those on Italian bits which would have been used for attaching the reins (unlike in modern curb-bits where they are used for attaching a chain) (Spratling 1972, 106). Despite their similarity in design, he concedes that the British ones must have been attached in a different way to the Italian ones, possibly by the use of straps instead of rings. However, their attachment, and thereby function would be difficult to achieve with these pieces (Moi Watson Pers. comm.), which means their function still remains in doubt. Palk is less emphatic: ‘the only function which can commonly be allotted to all rein hooks is that they were suspended from straps’ (Palk 1991, 83). She notes their pairing and context would suggest they were items of horse harness, and as with several other types of pieces such as strap unions, their flat undersides suggest they were laid flat with only the upper side visible. Palk does not believe they would have been strong enough to act as trace hooks - the straps or chains which take the pull from the breast collar and attach the horse to the vehicle.

'Toggles'

These are sometimes referred to as cheek pieces, but it is generally agreed that this was not their function. However, they are found in conjunction with bits so are likely to be used in harness (Spratling 1972, 125; Macgregor 1962, 31). MacGregor suggests they were like buckles in linking leather bits; they certainly have a perforation which would fit well with the width of a thick leather strap. Palk (1991, 509-514,) likens them to rein-stops, and illustrates a similar form used for several 19th century examples (Palk 1991, 625), but these seem in general smaller and lighter than the toggles from the Late Iron Age.

Figure A9.13: 'Toggle' 46.3-22 136 from Polden Hill.

Toggles are usually decorated, and when they are, the decoration is always on one surface only, and 'is always placed symmetrically about horizontal and vertical axes, both in terms of layout and (where applicable) colour combination' (Palk 1991, 73). The underside tends to be worn smooth, possibly by contact with the horse's skin or with leather. Their form and decoration suggests they were always worn one way round and were unlikely to turn or swivel when in position. There are many ways in which elaborate pieces of metal could be attached to horses. One possible position for a toggle could be on a 'false' martingale, a strap at the front of the horse or pony which passes between its front legs, to hold the collar in position; unlike a true martingale, it is not attached to the bridle. Many items could have been as much for decorative as practical use, and this could be the case for toggles.

Strap unions

Strap unions are found mainly in association with horse harness equipment, and the majority would have been used to join two straps together. Occasionally, as with button and loop fasteners, they may have been used to fasten clothing (Taylor and Brailsford 1985, 271). They range hugely in size, shape and degree of decoration, and also span a relatively large geographical area and timeframe, showing significant use from the second century BC to the second century AD (Taylor and Brailsford 1985, 247). Many, especially those associated with Iron Age contexts, are based on a figure of eight shape with bars at the side, and vary from small relatively plain objects to highly ornate and embellished artefacts.

Taylor and Brailsford (1985), divide the strap unions into four main types:

Type 1 is based on a figure of eight with a bar attached to each side; these date from the second century BC to the second century AD, with a concentration of Late pre-Roman Iron Age examples from Wessex.

Type 2 is similar to type 1, but the bars are concealed behind decorative plates, as with the Seven Sisters type (figure A9.15). These all date to the first century AD.

Type 3 has is central component shaped like a pointed oval, and the strap loops are concealed under projecting side elements. These date from the first to second centuries AD and are concentrated in the north of Britain.

Type 4 is a miscellaneous collection which includes other forms such as those with rectangular and circular shapes. Many of these occur in south east England.

Figure A9.14: Two examples of strap unions: 'Type 2 'Seven Sisters hoard (04.299) and 'Type 3' Middlebie Hoard (FA 56).

Other main features of strap unions in general comprise a relatively flat reverse surface with an extruding bar or bars at the sides or on the back for fastening leather straps, and a more decorative, sometimes moulded three-dimensional upper surface, which provides an ornamented feature in addition to the functional component of these objects.

Strap unions also include those described as 'quadrilobed' (Feachem 1991), which are some of the finest examples of Late La Tène art dating to the first century AD. These particular objects 'exhibit three dominant features of design: the four lobes, the two or four side crescents, and the main body or central element' (Feachem 1991, 219).

Figure A9.15: Quadrilobed strap Union from Santon 1897.225 showing elaborate inscribed and inlaid design on the obverse, and a relatively crudely cast and finished reverse.

Harness brooches

Fox (1958, 124 figure 76) suggested that harness brooches were used to fasten a caparison (an ornamental covering spread over the saddle of the horse, with the crupper strap going through the loops). They are often large with elaborated surfaces allowing complex designs with areas of inlaid glass or enamel. In this respect they can be similar in size and design to other enamelled harness attachments such as quadrilobed strap unions, but have a pin and catch-plate as well as one or more bars on the reverse. The shapes and designs are unique to each object, and as with the strap unions, they are only designed to be viewed from one side; the reverse shows no careful modelling apart from the positioning of the hinges and the bars, and has an uneven 'as cast' appearance.

Figure A9.16: Front and reverse of one of the horse brooch from Polden Hill (89 7-6.78).

Horse brooches only seem to occur in first century AD; and it might be that even though they were produced in elaborate Late La Tène style, they were a relatively late, possibly continentally inspired acquisition in terms of horse attire.

Button and Loop fasteners

Some of the strap fasteners and the button and loop fasteners could arguably be for use on clothing rather than horses, and there is still uncertainty on the matter. MacGregor does not include them within her discussion of horse trappings, but instead lumps them with 'smaller personal ornaments' (Macgregor 1976), and Spratling leaves them out of his recent analysis on the Middlebie horse harness equipment (Spratling 2011). However, the contexts in which many of these items have been found does imply they were for decorative harness equipment of some kind (Macgregor 1962, 23; Wild 1970, 145), and were perhaps used as terminals on leather straps (Wild 1970, 145). Button and loop fasteners were a relatively long-lived artefact type; moulds for these items were found with other horse related casting debris at Gussage All Saints (Spratling 1979, 134). Wild points out that 'The number of fasteners found on military sites suggest strongly that they were items of military equipment' (Wild 1970, 146). He also notes that these were particularly prevalent in northern British sites, and even after the Roman conquest continued to show considerable native influence in their design. (Wild 1970, 146)

Figure A9.17: A pair of button and loop fasteners from the Middlebie hoard (FA 54 and 53).

Chariot equipment

It is still believed that the majority of horses/ponies from the Middle to Late Iron Age were used to pull carts or chariots, and many items of horse gear were related to this use. Two typical reconstructions of such vehicles are illustrated below. Tyres are always iron, due to their function, but many of the other metal components are made from copper alloys and/or iron.

Terrets

'Terrets, the most common of all Celtic art forms, are not easily typed, nor are their changes easily understood or charted'(Garrow and Gosden 2012 , 17).

Terrets are rein rings which are attached to the yoke of a cart or chariot; and 'almost any plain ring which has an external diameter of between 35 and 90mm could have functioned as a terret' (Palk 1991, 13). Plain rings are sometimes found in association with other horse harness equipment (e.g. in the Middlebie Hoard), they could be unattached bridle-bit rings, but could equally well be terrets. There are relatively few recognisable terret rings on the continent; French early la Tène cart burials do contain rings which might have served the same purpose, and rings are also found in some of the Yorkshire cart burials (Spratling 1972, 25). However, Spratling believes that 'the British terrets must therefore almost exclusively be considered as British innovations' (Spratling 1972, 54), and most terrets from Britain have features such as loops, stops and attachment bars. Spratling adds that 'the diversity of forms in Britain is an insular peculiarity; moreover, it is interesting that the British terrets show hardly any sign of continental influence in their several design'(Spratling 1972, 25).

It is thought that one rein from each horse passed through a ring (totalling a set of four per chariot); a central fifth larger ring was also present on many 'sets'; but this latter terret may have been used to secure the yoke to the pole, rather than be used for reins (Savory 1973, 37; Macdonald 2007, 8), and is not always present (Carter and Hunter 2003). The positioning of terrets found in cart/chariot burials in Yorkshire and Scotland, and the wear facets on the inner sides of many of the terrets found in hoards confirm this interpretation (Stead 1991; Carter and Hunter 2003; Spratling 1972, 42; 1979, 134).

Aisling Nash (pers. comm.) believes that the yoke attaching the two ponies would be made from two separate units, joined by leather straps to the pole, which would result in the much needed flexibility when driving and turning a chariot; the fifth larger terret could be used for this attachment. Her theory comes from studying modern horse drawn vehicles, and from the fact that the lashing of the pole to the fixed yoke on the reconstructed chariots always comes loose.


Figure A9.18: The terrets in place on a model chariot; the four smaller terrets are attached to the yoke. Large decorative terret ring from Pentyrch: these large terrets were possibly placed at the centre of the yoke, placed where the yoke was tied to the pole (©National Museum of Wales).

Terrets can be made from iron or copper alloy, or a combination of both, e.g. a copper alloy ring with an iron bar (Spratling 1972, 27). Spratling believes that most of the terrets which include substantial amounts of iron are probably mostly of a relatively early date (Spratling 1972, 53).

Some are shown not to be solid castings, but have voids, or contain the ‘core’ material used during manufacture by the lost wax technique, as with those reported from Ferry Fryston and Hunsbury (O’Connor 2009; Barnes 1985). This manufacturing technique was probably to save on the amount of metal used, and was also practised for the casting of toggles. The terrets could be cast with the gate either at the top or on the bar; mould fragments from Gussage All saints (Spratling 1979, 134; Foster 1980, 30) were cast with the terrets upside down, whereas the casting gates from the mould fragments from Wheelsby Avenue were attached to the top of the loops (Foster 1995, 53).

There have been several detailed typologies adopted and adapted (for example by Leeds 1933, 118-126; Spratling 1972, 25-53; MacGregor 1976, 38-39), and as with many classificatory schemes of Iron Age horse equipment these give a complicated and variable picture of both chronology and geographical occurrence. They have a large variety of form, from ‘simple’ and ‘plain’ types to ‘winged’, ‘lipped’ and ‘platform’ types etc. Most of the terrets from the Late Iron Age hoards studied here are of relatively elaborate forms, and often involve further decoration on their rings and facets.

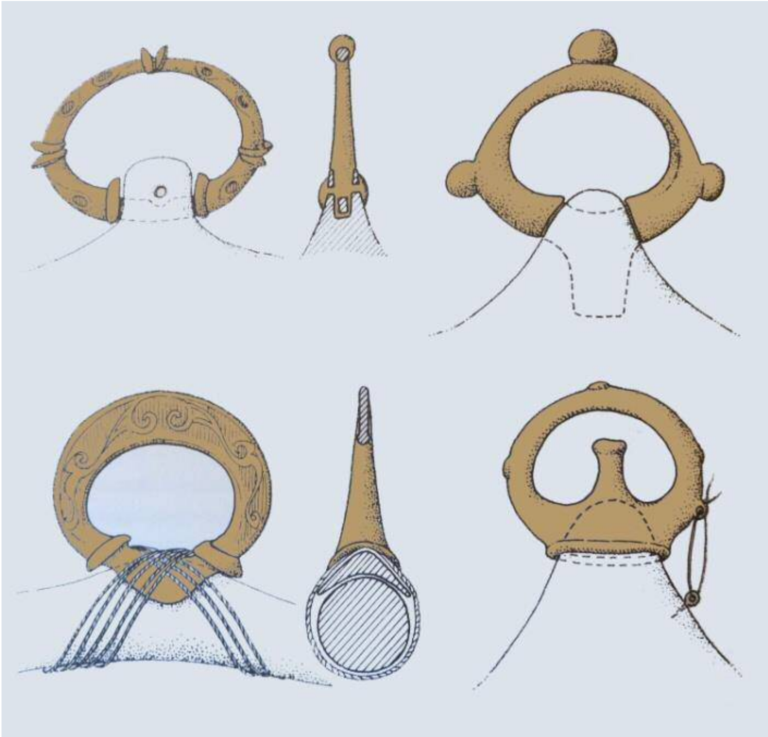


Figure A9.19: Ways of attaching various terret types to the yoke (after MacGregor 1976, 1. 40).

One notable aspect in the way terrets differ is by their means of attachment (figure A9.21); the majority are similar to the upper left hand example; many of the larger and most elaborate terrets have attachments like those on the lower left hand side, for example the large single terrets from the Polden Hill hoard (chapter 6). The lower right attachment type occurs on 'massive' terrets, which have a predominantly northern and western bias dating from the first to third centuries (MacGregor 1976, 1. 47).

Nave hoops

These are circular metal bindings of either iron or copper alloy which fit round the wooden naves or hub of the wheels on carts or chariots to prevent splitting. A relatively wide nave would help keep the wheel vertical and prevent wobbling on the axle, and nave hoops were probably attached to both sides of the wheel (Macdonald 2007, 25). These were definitely to do with the structural elements of the chariot or cart, but decorative bronze ones are present in the Llyn Cerrig Bach assemblage.

Figure A9.20: Selection of nave hoops from Llyn Cerrig Bach.

Figure A9.21: Model of a chariot wheel showing the position of of the nave hoops on the axle hub, and the use of linch pins (©National Museums of Wales).

Linch Pins

These were attached to the axles of wooden carts or chariots to hold the wheels in position and prevent them from falling off; they were inserted into the end of the shaft on the axle.

Figure A9.22: Linchpins from Llyn Cerrig Bach (©National Museum of Wales)

They were made predominantly form iron, as they performed a vital functional task in preventing the wheels coming away from the vehicle, but sometimes they incorporated decorative bronze ends (as with the Kirkburn example, figure A9.32); not surprisingly they are often found as pairs.

Axle caps

Axle caps, although present on continental vehicles from Hallstatt C and D (Piggott 1983, 160-164; Pare 1992, 88-90), seem to be a relatively uncommon find in Iron Age Britain, and their style and technology indicates they were probably a Late Iron Age, if not a Roman phenomenon, containing an unusual combination of material and design traits. Decoration seems to be more important than function. They have been categorised as axle caps by their size (particularly their diameters) and by their contexts, but relatively little has been written in detail.

There is a fragmentary axle cap from the Seven Sister hoard (Davies and Spratling 1976, 127-8), which has Roman style motif decoration cast or impressed into the metal. Although fragmentary, its diameter is probably about 50-60 mm, a width appropriate for placing on the end of a chariot or cart axle.

Figure A9.23: Axle cap fragments from Seven Sisters (NMW 04.148); possible axle cap from Stanwick (British Museum 1847,0208.86, © Trustees of the British Museum).

The axle cap from Folly Lane is dated to approximately AD 55 (Niblett 1999); it is inlaid with silver containing only 2.12% copper; this is an alloy typical of first century AD coins and high quality silverware in the Roman world (Northover 1999, 148). It had an internal diameter of approximately 80mm (Foster 1999, 148-50). A possible example occurs in the Stanwick/Melsonby hoard (MacGregor 1962, 52, 54; British Museum 1847,0208.86); this is made of iron but sheathed in copper alloy on its upper side (figure A.23).

A further unusual example is from Undy; although found in the foundation layers of a Roman building, this possibly superseded Iron Age activity at the site (Gwilt 2009). Here an elaborate but delicately cast 'spiky' construction indicates an object for appearance not use; each spike is largely hollow, though some silt/clay-like material remains inside, possibly the remains of the moulding material as seen in other objects such as the Ferry Fryston terret; the internal diameter at the rim measures 75-77mm. The alloy is a gun metal, which is relatively unusual for Iron Age horse equipment, so indicates Roman influence in metal use; but the skill employed to produce such a stunning complex object by *cire perdue* reflects outstanding Iron Age craftsmanship.

Figure A9.24: Axle cap from Undy (NMW PA 9951A3).

Potentially a further pair occurs in the Santon Hoard. These were classified by Spratling (2009) as 'ferrules', but are also catalogued as 'hub caps'; qualitative analysis shows they are made from brass. They have diameters of 51-53mm; which equates well with the other axle caps.

Figure A9.25: Axle cap 1897.227.20C from Santon.

All these examples have similar diameters, and a mixture of Roman and native traits and contexts and so form an interesting group in the take up and adaption of Roman and native material culture. Except for the Undy example, all are from secure first century AD contexts.

Conclusion

There are a large number of artefacts designed for use with horses or ponies and their carts or chariots. Some are entirely functional, and made of appropriate metal such as iron for tyres, and are never decorated; others encompass decoration within their function, such as linch pins and bridle-bits, and others are largely decorative, such as horse brooches. Horses increasingly become a vehicle for display; amongst all decorated items, there seemed to be a move towards producing areas on the objects (e.g. larger flatter surfaces on strap unions, wings on terrets etc) which could incorporate distinct and highly visible design elements, and these seemed to increase further as the middle to Late Iron Age progressed. Decorative surfaces became flattened, thereby enlarging the surface area to take increasingly elaborative decorative schemes. One such example can be illustrated by changes seen between the bridle-bits from Ulceby and Rise; the former has an intricately beautifully cast La Tène design, visible and valued by the owners(s), but subtle and not easily seen apart from those handling the object. Rise is colourful in its use of brass and coloured enamel, and in the positioning of the decoration. This increased elaboration is particularly prevalent in terrets, where enlarged and flattened ‘wings’ ‘platforms’ and ‘knobs’ take recessed glass and enamel. As Palk states: 'this relationship places emphasis on morphological development as a means of creating more space in order to increase the possibilities for innovative decorative design'. The most spectacular examples of all are the quadrilobed strap unions.

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